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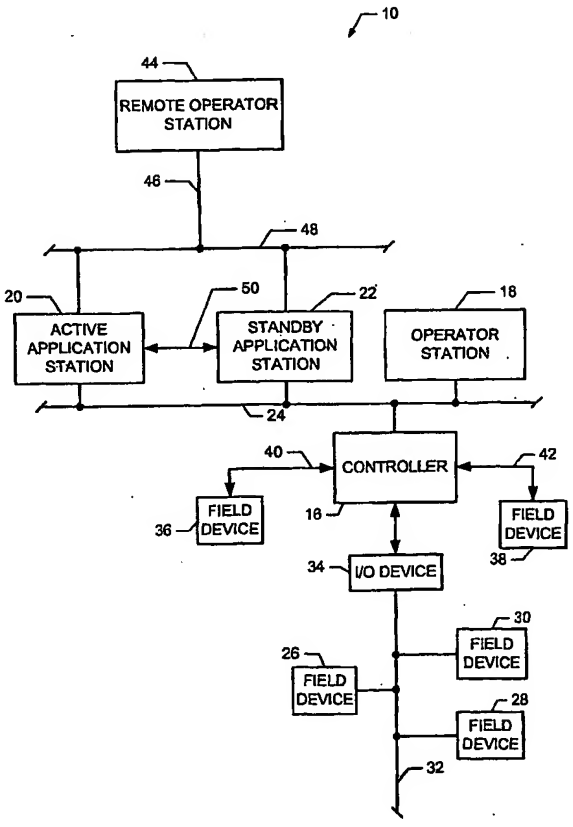
(54) Title: INTEGRATED GRAPHICAL RUNTIME INTERFACE FOR PROCESS CONTROL SYSTEMS




(57) Abstract: An integrated graphical runtime interface that provides a secure, highly available environment for process control systems is disclosed. In one example, a method for displaying process control information via a graphical user interface instantiates a runtime workspace application to operatively interpose between an operator station operating system and a user. The example method displays a plurality of panels via the graphical user interface and displays a portion of the process control information associated with a runtime application in at least one of the plurality of panels via the runtime workspace application.

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# INTEGRATED GRAPHICAL RUNTIME INTERFACE FOR PROCESS CONTROL SYSTEMS

## RELATED APPLICATION

**[0001]** This application is a regular filed application of and claims, for the purposes of priority, the benefit of U.S. Provisional Application Serial No. 60/567,980, entitled "Graphical User Interface for Representing, Monitoring, and Interacting with Process Control Systems," which was filed on May 4, 2004 and which this application hereby expressly incorporates by reference herein in its entirety. This application is also related to U.S. Patent Application Serial Number 10/625,481, entitled "Integration of Graphic Display Elements, Process Modules and Control Modules in Process Plants," which was filed on July 21, 2003, and which published as U.S. Publication No. 2004/0153804 on August 5, 2004, which, in turn, is a Continuation-in-Part of U.S. Patent Application Serial No. 10/278,469, entitled "Smart Process Modules and Objects in Process Plants," which was filed on October 22, 2002, and which published as U.S. Publication No. 2004/0075689 on April 22, 2004, the entire disclosures of which are hereby expressly incorporated by reference herein in their entirety. This application is also related to U.S. Patent Application Serial Number 10/368,151 entitled "Module Class Objects in a Process Plant Configuration System," which was filed on February 18, 2003, and which published as U.S. Publication No. 2004/0199925 on October 7, 2004, the entire disclosure of which is hereby expressly incorporated by reference herein in its entirety. This application is also related to the following patent applications, which are being filed as International (PCT) applications on the same date as this application and which this application hereby expressly incorporates by reference herein in their entirety: "Associated Graphic

Displays in a Process Environment" (Atty. Docket No. 06005/41111); "User Configurable Alarms and Alarm Trending for Process Control Systems" (Atty. Docket No. 06005/41112); "Integration of Process Modules and Expert Systems in Process Plants" (Atty. Docket No. 06005/41113); "A Process Plant User Interface System Having Customized Process Graphic Display Layers in an Integrated Environment" (06005/41114); "Scripted Graphics in a Process Environment" (Atty. Docket No. 06005/41115); "Graphics Integration into a Process Configuration and Control Environment" (Atty. Docket No. 06005/41116); "Graphic Element with Multiple Visualizations in a Process Environment" (Atty. Docket No. 06005/41117); "System for Configuring Graphic Display Elements and Process Modules in Process Plants (Atty. Docket No. 06005/41118); "Graphic Display Configuration Framework for Unified Process Control System Interface" (Atty. Docket No. 06005/41124); "Markup Language-Based, Dynamic Process Graphics in a Process Plant User Interface" (Atty. Docket No. 06005/41127); "Methods and Apparatus for Modifying Process Control Data" (Atty. Docket Nos. 06005/591622 and 20040/59-11622); "Methods and Apparatus for Accessing Process Control Data" (Atty. Docket Nos. 06005/591623 and 20040/59-11623); and "Service-Oriented Architecture for Process Control Systems" (Atty. Docket Nos. 06005/591629 and 20040/59-11629).

## FIELD OF THE DISCLOSURE

**[0002]** The present invention relates generally to process control systems and, more specifically, to an integrated graphical runtime interface for process control systems.

## BACKGROUND

[0003] Process control systems, like those used in chemical, petroleum or other processes, typically include one or more process controllers and input/output (I/O) devices communicatively coupled to at least one host or operator workstation and to one or more field devices via analog, digital or combined analog/digital buses. The field devices, which may be, for example, valves, valve positioners, switches and transmitters (e.g., temperature, pressure and flow rate sensors), perform functions within the process such as opening or closing valves and measuring process parameters. The process controllers receive signals indicative of process measurements made by the field devices and/or other information pertaining to the field devices, use this information to implement a control routine, and then generate control signals that are sent over the buses or other communication lines to the field devices to control the operation of the process. In this manner, the process controllers may execute and coordinate control strategies using the field devices via the busses and/or other communication links communicatively coupling the field devices.

[0004] Information from the field devices and the controllers may be made available to one or more applications (i.e., software routines, programs, etc.) executed by the operator workstation (e.g., a processor-based system) to enable an operator to perform desired functions with respect to the process, such as viewing the current state of the process (e.g., via a graphical user interface), evaluating the process, modifying the operation of the process, etc. Many process control systems also include one or more application stations. Typically, these application stations are implemented using a personal computer, workstation, or the like that is communicatively coupled to the controllers, operator workstations, and other systems within the process control system via a local area network (LAN). Each application

station may execute one or more software applications that perform campaign management functions, maintenance management functions, virtual control functions, diagnostic functions, real-time monitoring functions, safety-related functions, configuration functions, etc. within the process control system.

**[0005]** Process control systems typically provide one or more operator terminals and/or application stations including one or more graphical interfaces to enable system operators to view current process-related parameters, statistical and/or historical process information, alarm information, campaign management and/or execution information or, more generally, information provided by any or all of the applications associated with the process control system.

**[0006]** With some known process control systems, one or more of the process control-related applications include user interface functionality to enable the application(s) to interact directly with, for example, an operating system (e.g., a Windows-based operating system) of an operator station or terminal providing a graphical interface to the process control system. Thus, in these cases, the various applications and, in particular, the graphical user interface portions thereof interact directly and independently (i.e., independent of the other applications) with the operating system of the operator station. As a result, the system operators are responsible for managing and/or coordinating the use of a number of graphical displays (e.g., display windows) rendered via a display device (e.g., a video monitor or other display device) of the operator station. The management of these relatively independent displays or windows is complicated by the fact that each of the displays may provide a different type of information (e.g., graphical, textual, trends, alarms, etc.) at different times. For example, some information may be best displayed in the form of a banner placed at the top or bottom of a display device (e.g., a video

monitor), other information may be best displayed in a relatively large central display area, and still other information may be best displayed in the form of a temporary pop-up floating display or window.

[0007] In some cases, the display management duties imposed on the system operator may include arranging, sizing, and/or scaling the various display windows to fit within the form factor of a particular display platform (e.g., a workstation or personal computer monitor, a personal data assistant, a smart phone, tablet personal computer, etc.). Further, even if a system operator is able to configure and organize the independent graphical displays in a useful manner for a given set of process control information provided by a particular group of applications, adding and/or changing the information displayed may require time consuming reorganization or reconfiguration of the display. For example, if the system operator desires to add alarm information to a display that is currently not displaying alarm information, the entire display may have to be reorganized by moving, resizing, and/or eliminating one or more of the current displays and/or windows to fit within the form factor of the display.

[0008] Another difficulty resulting from requiring system operators to organize and/or manage the layout and operation of the graphical user interface is that each of a plurality of displays, which may be associated with a respective plurality of operator and/or application stations distributed throughout the process control system, may use a different combination and layout of graphical views or displays. This lack of a common display framework leads to inconsistency across the various displays used in the process control system, thereby reducing the intuitiveness and/or proficiency with which an operator interacts with the various displays and complicates the training of new system operators and/or other personnel.

[0009] Additionally, because many known graphical user interfaces are not integrated within a common runtime environment and enable system operators to interact directly with the operating system, system operators can purposefully and/or inadvertently disable one or more vital runtime graphical user interfaces. For example, with such direct access to the operating system underlying a graphical interface that provides alarm information, a system user could potentially disable the reporting of alarm information, which may result in the failure to respond to an unacceptable and/or dangerous condition within a plant.

## SUMMARY

[0010] In one example, a method and apparatus for displaying process control information via a graphical user interface instantiates a runtime workspace application to operatively interpose between an operator station operating system and an operator. The example method and apparatus also displays a plurality of panels via the graphical user interface and displays a portion of the process control information associated with a runtime application in at least one of the plurality of panels via the runtime workspace application.

[0011] Another example method and apparatus for displaying process control information via a graphical user interface establishes a workspace framework having a plurality of display panels, assigns display category information to each of the display panels, and assigns a category to process control information to be displayed. The example method and apparatus also compares the category assigned to the process control information to be displayed to the category information assigned to the display panels and selects one of the display panels to display the process control information to be displayed based on the comparison.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a block diagram of an example process control system that uses the integrated graphical runtime interface described herein.

[0013] FIG. 2 is a block diagram depicting an example service-oriented architecture or structure 200 that may be used within the example process control system of FIG. 1 to implement the integrated graphical runtime interface described herein.

[0014] FIG. 3 is a block diagram depicting the relationship between runtime applications, services, and the example integrated graphical runtime interface described herein.

[0015] FIG. 4 is a more detailed block diagram of one manner in which the example integrated graphical runtime interface described herein may be used to operatively couple process control graphics to one or more services.

[0016] FIG. 5 is an example display framework that may be used by the example integrated graphical runtime interface described herein.

[0017] FIGS. 6 and 7 depict an example manner in which one or more display panels may be moved within a display generated by the example integrated graphical runtime interface described herein.

[0018] FIGS. 8 and 9 depict an example manner in which one or more display panels may be copied within a display generated by the example integrated graphical runtime interface described herein.

[0019] FIG. 10 is an example display panel assignment process that may be used by the example integrated graphical runtime interface described herein.

[0020] FIG. 11 depicts an example processor system that may be used to implement the apparatus and methods described herein.

## DETAILED DESCRIPTION

[0021] In general, the example apparatus, methods, and articles of manufacture described herein may be used within a process control system to provide a highly integrated graphical user interface environment for use by a variety of personnel associated with the configuration and/or operation of a process control system. More specifically, the example integrated graphical user interface described herein may be used to host one or more process control applications such as, for example, process monitoring applications, alarm management applications, process trending and/or history applications, batch processing and/or campaign management applications, streaming video applications, advanced control applications, etc. More generally, the example integrated graphical user interface described herein may be used to host applications associated with the development, deployment, configuration, design, customization, operation, maintenance, and/or support of a process control system. Personnel such as, for example, information technology personnel, configuration engineers, system operators, technical support engineers, software development engineers, test engineers, etc. may utilize various aspects of the example integrated graphical user interface described herein to perform their duties.

[0022] In contrast to some known graphical user interfaces for process control systems, the example integrated graphical user interface described herein may be used to aggregate and coordinate the graphical user interface functionality or operations of multiple applications. In particular, as described in greater detail below, the example graphical user interface may provide predefined display layouts or templates composed of a display area having one or more display panels or areas. Some of the display panels may be fixed in place relative to the overall display area, some panels

may be stacked on other panels, and still other panels may be floating or pop-up panels that appear temporarily over one or more other panels (i.e., occluding partially or completely the one or more other panels). Certain panels may be assigned to receive information for rendering or display from one or more particular applications. Alternatively or additionally, one or more applications may send process control-related information to be rendered or displayed to the example integrated graphical interface together with information specifying within which panel(s) the information may be or must be displayed. In this manner, the example integrated graphical user interface can automatically manage the display (e.g., the layout, scaling, etc.) of information from one or more process control-related applications within a unified display space or workspace, thereby reducing or minimizing the display management duties of system operators and/or other personnel associated with the process control system. The automatic management of display information may include automatic adjustment or adaptation of displayed information in a manner that best renders or displays the information on a particular hardware/software platform having a particular display device size, configuration, capabilities, etc.

**[0023]** In addition to minimizing display management duties of system operators and/or other personnel associated with the process control system, the automatic display management functions performed by the example integrated graphical user interface described herein can result in more consistent display scenarios and, thus, can improve the intuitiveness of the displays, simplify training, reduce operator errors (particularly in high stress process control situations or environments), etc. For example, the integrated graphical user interface described herein may be configured to provide substantially consistent visual elements (e.g., display panel geometries,

placements, sizes, use assignments or conventions, etc.) for some or all of the runtime applications managed by the integrated graphical user interface.

**[0024]** In further contrast to some known graphical runtime interfaces for process control systems, the example integrated graphical runtime interface described herein may be configured to operatively interpose between the runtime applications it manages and an underlying operating system of the operator workstation. More specifically, the example graphical runtime interface described herein is different from some known windows-type applications in that example graphical runtime interface utilizes a runtime workspace application that operatively interposes between users (e.g., system operators and/or other personnel) and the underlying operating system. In other words, the runtime workspace application may operate to encapsulate runtime application(s) so that the user is insulated/prevented from interacting directly with the underlying operating system and/or other applications. For example, the runtime workspace application employed by the example integrated graphical user interface described herein may intercept and/or trap certain key sequences, commands, etc. issued by the user.

**[0025]** Thus, the runtime workspace application used by the example integrated graphical runtime interface described herein may be employed to prevent users from inadvertently (or purposefully) damaging applications or data, gaining access to applications with which they are not authorized to interact, or carrying out any other actions that could potentially compromise the operation of the process control system. For example, the example integrated graphical runtime interface described herein may encapsulate the runtime applications with which a user interacts to prevent the user from closing one or more of the applications, interrupting or otherwise disrupting the

execution of the applications via commands directed to the operating system underlying the runtime applications, etc.

[0026] As described in greater detail below, the runtime workspace used by the example integrated graphical runtime interface describe herein provides a reliable, robust environment in which runtime applications (e.g., user interface applications and/or any other applications) can be sited, and provides a secure environment for executing runtime applications by preventing users from compromising the operation the runtime applications or damaging the data associated therewith.

[0027] Now turning to FIG. 1, a block diagram of an example process control system 10 that uses the example integrated graphical runtime interface described herein is shown. As depicted in FIG. 1, the process control system 10 includes a controller 16, an operator station 18, an active application station 20 and a standby application station 22, all of which may be communicatively coupled via a bus or local area network (LAN) 24, which is commonly referred to as an application control network (ACN). The operator station 18 and the application stations 20 and 22 may be implemented using one or more workstations or any other suitable computer systems or processing units. For example, the application stations 20 and 22 could be implemented using single processor personal computers similar to an example processor system 1102 shown in FIG. 11 below, single or multi-processor workstations, etc. In addition, the LAN 24 may be implemented using any desired communication medium and protocol. For example, the LAN 24 may be based on a hardwired or wireless Ethernet communication scheme, which is well known and, thus, is not described in greater detail herein. However, as will be readily appreciated by those having ordinary skill in the art, any other suitable communication medium and protocol could be used. Further, although a single LAN is shown, more than one

LAN and appropriate communication hardware within the application stations 20 and 22 may be used to provide redundant communication paths between the operator station 18, the application stations 20 and 22, and the controller 16.

**[0028]** The controller 16 may be coupled to a plurality of smart field devices 26, 28 and 30 via a digital data bus 32 and an input/output (I/O) device 34. The smart field devices 26-30 may be Fieldbus compliant valves, actuators, sensors, etc., in which case the smart field devices 26-30 communicate via the digital data bus 32 using the well-known Fieldbus protocol. Of course, other types of smart field devices and communication protocols could be used instead. For example, the smart field devices 26-30 could instead be Profibus or HART compliant devices that communicate via the data bus 32 using the well-known Profibus and HART communication protocols. Additional I/O devices (similar or identical to the I/O device 34) may be coupled to the controller 16 to enable additional groups of smart field devices, which may be Fieldbus devices, HART devices, etc., to communicate with the controller 16.

**[0029]** In addition to the smart field devices 26-30, one or more non-smart field devices 36 and 38 may be communicatively coupled to the controller 16. The non-smart field devices 36 and 38 may be, for example, conventional 4-20 milliamp (mA) or 0-10 volts direct current (VDC) devices that communicate with the controller 16 via respective hardwired links 40 and 42.

**[0030]** The controller 16 may be, for example, a DeltaV™ controller sold by Emerson Process Management, LLLP. However, any other controller could be used instead. Further, while only one controller is shown in FIG. 1, additional controllers of any desired type or combination of types could be coupled to the LAN 24. The controller 16 may perform one or more process control routines associated with the

process control system 10. Such process control routines may be generated by a system engineer or other system operator using the operator station 18 and downloaded to and instantiated in the controller 16.

**[0031]** As depicted in FIG. 1, the example process control system 10 may also include a remote operator station 44 that is communicatively coupled via a communication link 46 and a LAN 48 to the application stations 20 and 22. The remote operator station 44 may be geographically remotely located, in which case the communication link 46 is preferably, but not necessarily, a wireless communication link, an internet-based or other packet-switched communication network, telephone lines (e.g., digital subscriber lines), or any combination thereof.

**[0032]** As depicted in the example of FIG. 1, the active application station 20 and the standby application station 22 are communicatively coupled via the LAN 24 and via a redundancy link 50. The redundancy link 50 may be a separate, dedicated (i.e., not shared) communication link between the active application station 20 and the standby application station 22. The redundancy link 50 may, for example, be implemented using a dedicated Ethernet link (e.g., dedicated Ethernet cards in each of the application stations 20 and 22 that are coupled to each other). However, in other examples, the redundancy link 50 could be implemented using the LAN 24 or a redundant LAN (not shown), neither of which is necessarily dedicated, that is communicatively coupled to the application stations 20 and 22.

**[0033]** Generally speaking, the application stations 20 and 22 continuously, by exception, or periodically, exchange information (e.g., in response to parameter value changes, application station configuration changes, etc.) via the redundancy link 50 to establish and maintain a redundancy context. The redundancy context enables a seamless or bumpless handoff or switchover of control between the active application

station 20 and the standby application station 22. For example, the redundancy context enables a control handoff or switchover from the active application station 20 to the standby application station 22 to be made in response to a hardware or software failure within the active application station 20 or in response to a directive from a system operator or user or a client application of the process control system 10.

**[0034]** FIG. 2 is a block diagram depicting an example service-oriented architecture or structure 200 that may be used within the example process control system 10 of FIG. 1 to implement the integrated graphical runtime interface described herein. Thus, before further describing the example integrated graphical runtime interface, a discussion of the example service-oriented architecture 200 is provided below.

**[0035]** Turning in detail to FIG. 2, the example service-oriented architecture 200 includes a server 202 and a client 204. The server 202 includes a plurality or collection of services 206, 208, and 210, some or all of which may perform related functions. The services 206, 208, and 210 provide respective interfaces (e.g., one or more sets of exposed parameters) 212, 214, and 216 that enable communication with the client 204 via a communication port 218. The service interfaces 212, 214, and 216 are substantially generic in nature and, thus, are substantially independent of the schemas (i.e., data format, protocol, etc.) used for the data contained in configuration and/or runtime databases associated with the example process control system 10 of FIG. 1. As a result, the service interfaces 212, 214, and 216 only require modification (e.g., updating) if new service capabilities (e.g., functions) are added to one or more of the services 206, 208, and 210. Thus, the service interfaces 212, 214, and 216 do not have to be changed if new data objects are added for use within the process control system 10 (FIG. 1).

[0036] The server 202 may be implemented as software executed on a processor-based system such as, for example, one or more of the application stations 20 and 22 and/or operator stations 18 and 44 shown in the example system 10 of FIG. 1. Of course, the server 202 may be implemented using any other processor-based system or workstation coupled to the example process control system 10 (FIG. 1).

[0037] The client 204 includes a plurality of service interface proxies 220, 222, and 224, each of which corresponds to one of the services 206, 208, and 210. The number of service interface proxies used by the client 204 may be fewer than the number of services provided by the server 202. In other words, the client 204 preferably creates proxies only for the services to which it requires access. Thus, the client 204 may generate one or more proxies as needed to access or interact with one or more of the services 206, 208, and 210 provided by the server 202.

[0038] Similar to the server 202, the client 204 may be implemented as software executed on a processor-based system such as, for example, one or more of the application stations 20 and 22 and/or one or more of the operator stations 18 and 44. In one example implementation, the client 204 may utilize a web browser framework (e.g., Internet Explorer) or the like to access one or more of the services 206, 208, and 210 provided by the server 202. However, any other desired software framework may be used instead of or in addition to such a web browser framework. More generally, the client 204 may represent any desired application within the example process control system 10 (FIG. 1). Thus, the client 204 may, for example, be a configuration application, a maintenance application, a monitoring application, a process control application, and/or any other application or combination of applications. As described in greater detail in connection with FIGS. 3 and 4 below, the client 204 (i.e., the client application(s)) may include display functionality (e.g., graphical user

interface functionality) to enable one or more system operators, engineers, and/or any other users to view and/or change process control data during configuration operations, runtime, etc.

[0039] While the example architecture 200 of FIG. 2 depicts a single server in communication with a single client, additional servers and clients may be used if desired. For example, in some implementations, the client 204 may communicate with, interoperate with, and/or access services in more than one server. Likewise, in these implementations or other implementations, the example server 202 (or other individual servers) may communicate with and/or interoperate with multiple clients.

[0040] Thus, with the example service-oriented architecture 200 of FIG. 2, the services 206, 208, and 210 are substantially decoupled (e.g., in terms of data dependencies) from one another and from applications that make use of (e.g., call) the services 206, 208, and 210. Such decoupling advantageously enables the software associated with each of the services 206, 208, and 210 to be independently modified or versioned and released for field use without having to modify or version the application(s) that are utilized by the client 204 and which access the services 206, 208, and 210. Likewise, the application(s) associated with the client 204 may be independently modified or versioned without having to modify or version the services 206, 208, and 210, as long as the application(s) associated with the client 204 adhere to or are compatible with the interfaces 212, 214, and 216 of the respective services 206, 208, and 210. Thus, instead of statically defining relationships between the applications associated with the client 204 and one or more of the services 206, 208, and 210 by fixing such relationships (i.e., creating data dependencies) at the time the software associated with the applications and/or the services 206, 208, and 210 is generated, the example architecture 200 of FIG. 2 allows such relationships to be

established dynamically at runtime. Further details relating to the example service-oriented architecture described above may be found in International Patent Application No. PCT/_____, entitled "Service-Oriented Architecture for use with Process Control Systems, filed on May 4, 2005, the entire disclosure of which is incorporated by reference herein.

**[0041]** FIG. 3 is a block diagram depicting an example graphical runtime interface 300. As shown in FIG. 3, a plurality of runtime applications 302 are communicatively or operatively coupled to a runtime workspace 304 and a collection of services 306. More specifically, the runtime applications 302 and the services 306 may be operatively or communicatively coupled using the example service-oriented architecture 200 (FIG. 2). In that case, the services 306 (e.g., the services 206, 208, and 210) may be provided by one or more servers or other processing system(s) (e.g., the sever 202). Additionally, the services 306 may include database services that provide process control-related information, history services that provide historical information related to the process control system 10 (FIG. 1), alarms and/or events services, and/or any other services accessed or used by the process control system 10 (FIG. 1). Further, the runtime applications 302 may be provided via one or more clients (e.g., the client 204 of FIG. 2) and, thus, may be communicatively or operatively coupled to the services 306 via proxies (e.g., the proxies 220, 222, and 224). In the example of FIG. 3, the runtime applications 302 include a trending application 308, an advanced control application 310, and a process graphics application 312, which receives information from a batch application 316 and/or an alarms (and/or events) application 314. However, one or more additional or different applications from those specifically depicted in FIG. 3 may be used instead. For example, campaign management applications, streaming video applications, and/or

any other applications associated with the development, deployment, configuration, design, customization, operation, maintenance, and/or support of a process control system may be used.

**[0042]** In general, graphical displays provided by the runtime applications 302 are sited in or encapsulated by the runtime workspace 304 to provide an integrated runtime display, which may contain information from one or more of the applications 302 at a given time. In particular, the runtime workspace 304 may be configured to automatically arrange, scale, etc. a plurality of panels, each of which may contain information pertaining to a different one of the services 306, within a display to minimize the display (or windows) management duties imposed on system operators and/or other personnel. Such automatic placement, layout, etc. of the display panels results in more consistent display scenarios, thereby improving the intuitiveness of the displays, simplifying training, reducing operator errors, etc.

**[0043]** Also, generally, the runtime workspace 304 enables personnel such as system operators, engineers, etc. to interact with the runtime applications 302 via a graphical user interface provided by the runtime workspace 304 in a safe, robust, and secure manner. More specifically, the runtime workspace 304 may be implemented as software or other machine readable and executable instructions or code that operatively interposes between the runtime applications 302 and an underlying operating system, which may be, for example, a Windows operating system or any other suitable operating system. In this manner, the runtime workspace 304 may be configured to prevent users from interacting directly with underlying applications, including, for example, the underlying operating system. For example, in some example implementations, the runtime workspace 304 may intercept and/or trap certain key sequences, commands, etc. issued by the user.

[0044] The runtime workspace 304 may be configured to provide multiple operational modes. One example operational mode provides a dedicated or controlled desktop (e.g., a kiosk type) interface that prevents system administrators, system operators, and/or other personnel from inadvertently or purposefully damaging or compromising applications and/or the data associated with those applications. Another example operational mode for the runtime workspace 304 enables certain designated or authorized users to use the runtime workspace 304 in conjunction with other applications such as, for example, Windows-based applications under substantially less restrictive conditions than provided by the controlled desktop mode mentioned above.

[0045] In some examples, the runtime workspace 304 may be implemented using, for example, a server (e.g., the server 202) that is configured to automatically start in the dedicated and controlled desktop mode upon boot-up. In such examples, the runtime workspace 304 may permit only one instance of the runtime workspace 304 to be instantiated within the server. Certain users may have permission or authorization to subsequently cause the runtime workspace 304 to switch to the less restrictive operating mode mentioned above.

[0046] The runtime workspace 304 may also provide a reset mechanism that may be used during operation of the runtime workspace 304 to revert to an initial startup condition or configuration without requiring the server on which the runtime workspace 304 is resident and operating to be shut down and restarted. This reset mechanism may be invoked by a system operator to restore the proper operation of the runtime workspace 304 in the event that the runtime workspace 304 is malfunctioning. The initial conditions to which the reset restores the runtime

workspace 304 may include initial and/or default display framework contents (e.g., views, panel arrangements, etc.).

[0047] While operating in the dedicated and controlled or restricted operational mode, the runtime workspace 304 may be configured to prevent users from instantiating and interacting with impermissible programs or applications. Such impermissible programs or applications may include programs or applications that could compromise the operation of the runtime applications 302 and/or the runtime workspace 304. In examples where the runtime applications 302 and/or the runtime workspace 304 utilize a Windows-based operating system (e.g., Microsoft Windows), the runtime workspace 304 may disable access to the Start dialog (e.g., Windows key and Cntrl-Esc), the Windows taskbar, and Windows desktop shortcuts. Additionally, the runtime workspace 304 may disable access to the Windows keyboard shortcuts including, for example, Run dialog (WinKey + R), Minimize all (WinKey + M), switch to another (non-runtime workspace) application (Alt-tab), OS Explorer (WinKey + E), etc.

[0048] The controlled and dedicated operational mode of the runtime workspace 304 may be configured (e.g., by a system configuration specialist) to present users with a list of applications that can be run while in the restrictive controlled and dedicated operational mode. Such a list of applications may include or may be limited to non-runtime workspace applications that do not permit an operator to alter or delete files, launch further unconstrained applications, etc.

[0049] The runtime workspace 304 is also configured to prevent users from rendering the runtime workspace 304 inoperative when in the restrictive dedicated and controlled operational mode. To prevent users from rendering the runtime workspace 304 inoperative, the runtime workspace 304 may not allow the termination

of the runtime workspace application by, for example, the Alt-F4 or Exit menu items. Additionally, the access to the Windows (e.g., in the case where Windows is the underlying operating system) security dialog is disabled, access to the windows keyboard shortcuts is disabled (e.g., minimize all (WinKey + M), lock workstation (WinKey + L) is disabled, access to the windows display properties dialog is disabled to prevent changes to, for example, the display color, depth and resolution settings, appearance preferences, themes, wallpaper, etc. Still further, the runtime workspace 304 may disable screen savers and any other similar applications that could potentially interrupt otherwise compromise the continuous display of graphic process control information via the runtime workspace 304.

**[0050]** In cases where a web browser or access to a web browser is provided by the runtime workspace 304 such a web browser may permit constrained browsing. For example, only web pages associated with a collection of predetermined, authorized uniform resource locators (URL's) may be displayed or rendered via the runtime workspace 304. Such URL's may include or may be limited to URL's associated with web pages and/or other documents stored on intranet servers.

**[0051]** To ensure that the runtime applications 302 do not compromise the operation of the runtime workspace or each other, the runtime applications 302 are configured to prevent access to operating system (e.g., Windows) folder and file properties (e.g., during the performance of file browsing operations). Nor do the runtime applications 302 permit the properties or security requirements of the file to be changed, unless doing so could not result in damaging or otherwise compromising the software or data installed on that workstation.

**[0052]** As noted above, when operating in the less restrictive operational mode, the runtime workspace 304 can be used in conjunction with other Windows applications

by certain authorized personnel. This less restrictive operational mode may be used to enable system configuration personnel to interact with workspace configuration, display configuration, and/or any other configuration applications. Additionally, this less restrictive operational mode may be used to enable users to access debugging features that may only be suitably accessed by the authorized personnel. Still further, this less restrictive operational mode may be used to enable users to troubleshoot the runtime workspace 304.

**[0053]** While operating in the less restrictive operational mode, the runtime workspace 304 enables the authorized users to utilize operating system functions (e.g., Windows functions) including, for example, the task bar, the Start button, the Run dialog, and the like. Additionally, the Windows key and Windows key shortcuts may be used, as can the application minimization function and application switching function (Alt-tab). Still further, the user is provided an unrestricted ability to change display properties and to terminate one or more of the runtime applications 302. Users may also be permitted to switch from the less restrictive operational mode to the more restrictive dedicated and controlled operational mode without having to provide security keys or any other authorization. Upon performing such a switch of operational modes, the runtime workspace 304 retains substantially all or most of the workspace context (e.g., panel content, recently used history, etc.) for rendering in the display provided in the more restrictive operational mode.

**[0054]** The less restrictive operational mode also enables the authorized users to create another operating system (e.g., Windows) application window on the operating system desktop (e.g., the Windows desktop). The additional application window enables user to create new displays including content that may be managed by the users. For example, the additional application window may include content from any

of the framework panels composing the runtime workspace 304 and that content may be positioned, sized, scrolled through, minimized, maximized, closed, etc. as desired by the users. Also, for example, an additional application may be used to test or compare multiple different display frameworks (e.g., panel layouts, content configurations, different languages, etc.).

**[0055]** As noted above, the less restrictive operational mode provided by the runtime workspace 304 provides relatively unrestricted access to the Windows desktop, thereby enabling users to run new or additional instances of the runtime workspace application (e.g., the runtime workspace 304). A new or additional instance of the runtime workspace application 304 may be started in the dedicated and controlled (i.e., restricted) operational mode or, alternatively, the less restricted operational mode discussed above. In the case where the new or additional instance is started in the dedicated and controlled operational mode, other applications (i.e., non-runtime applications) may be inaccessible. On the other hand, in the case where the new or additional instance is started in the less restrictive operational mode, the user(s) may be permitted to run multiple instances of the runtime workspace 304.

**[0056]** The example runtime workspace 304 may also be configured to provide alternate language functionality. For example, the runtime workspace 304 may be instantiated to utilize a dominant language (e.g., English), which may be selected by default so that all workspace behaviors and interactions (e.g., messages, menu items, etc.) use that default language. If desired, a user may be permitted to select an alternate language (i.e., a language other than the default language) during the operation of the runtime workspace 304.

**[0057]** Turning again to the runtime applications 302, as noted above, the runtime applications 302 are communicatively coupled to and substantially controlled by the

runtime workspace 304. Additionally, the runtime applications 302 may be configured to comply with interface conventions defined by the runtime workspace 304. For example, the runtime applications 302 are configured so that scaling, scrolling, selecting, and other user interface functions are implemented in a consistent manner to provide an integrated look and user experience via the runtime workspace display. Further, as described in greater detail below, each of the applications 302 may be assigned to display in a particular one or set of display panels composing the runtime workspace display. The applications 302 are preferably, but not necessarily, configured to automatically adjust the display information provided to the runtime workspace 304 for the display panel in which the display information will be rendered. For example, in the case where an application recognizes that its content will be displayed in a floating panel (i.e., a display panel that may overlay and/or occlude other panels) the application provides graphic layout information suitable for use in rendering the information within the initial size or configuration of the floating panel. Further discussion relating to the display panels is provided below in connection with FIGS. 5-10.

**[0058]** FIG. 4 is a more detailed block diagram of one manner in which the example integrated graphical runtime interface described herein may be used to operatively couple process control graphics to one or more services. As shown in FIG. 4, the runtime workspace 304 includes a runtime workspace application domain 402. Although not shown in FIG. 4, the runtime workspace 304 may host additional application domains, each of which may be associated with a different runtime application and/or service. For example, the trending application 308 and the advanced control application 310 of FIG. 3 may be implemented using different, additional application domains within the runtime workspace 304.

[0059] The runtime workspace 304 provides a process graphics display manager 404 that manages the operation of one or more display services 406 and 408, each of which may be associated with respective display panels provided by the runtime workspace 304. The process graphics display manager 404 may be configured to accept requests from the runtime workspace 304 to display a faceplate (e.g., via a pop-up panel such as the floating panel described below in connection with FIG. 5) or another display within the runtime workspace 304 and carries out those requests by calling one or both of the display services 406 and 408. As depicted in FIG. 4, each of the display services 406 and 408 is instantiated in a respective application domain. While two display services 406 and 408 are shown in FIG. 4, more or fewer than two display services may be used instead.

[0060] The display services 406 and 408 include respective rendering engines 410 and 412. In this example, the rendering engines 410 and 412 are configured to render process control-related graphics. More specifically, the rendering engines 410 and 412 load display and supporting display control assemblies, which are created or instantiated and then rendered to display panels or panes. The rendering engines 406 and 408 include respective data sources 414 and 416. The data source 414 is communicatively coupled to a runtime server 420, which may provide a change notification service, among other services, via a proxy 418. Similarly, the data source 416 may be communicatively coupled to the runtime server 420 via a proxy 422 and may also be communicatively coupled to an alarm server 424, which may provide an alarm summary service among other services, via a proxy 426.

[0061] In operation, the display services 406 and 408 are created or instantiated by the process graphics manager 404 and then registered with the services 420 and 424, respectively. The process graphics manager 404 may then communicate with a

runtime pane component 428, which is part of the runtime workspace 304, to obtain the context or handle associated with the display panel(s) in which the display services 406 and 408 are to render their respective displays. Thus, the runtime pane component 428 is configured to create the panel in which the display(s) are to be rendered.

**[0062]** As shown in FIG. 4, the process graphics display manager 404 is communicatively coupled to a local display repository service 430 via a proxy 432. The local display repository service 430 is configured to retrieve display information from a local display cache 434 or, if the needed display information is not stored in the local display cache 434, then from a global display cache 436 via a global display repository service 438 and proxy 444. The local display repository service 430 may be instantiated within the local operator's station (e.g., the same station or server that hosts the runtime workspace 304) and the global display repository service 438 may be instantiated in another node (e.g., a different workstation or server than the station or server in which the runtime workspace 304 is instantiated).

**[0063]** FIG. 5 is an example display framework 500 that may be used by the example integrated graphical runtime interface described herein. In general, the workspace framework 500 provides a user-configurable display layout that may be composed of a plurality of display panels, each of which may contain graphic information pertaining to a different runtime application. In this manner, the display framework 500 provides a highly integrated graphical user interface with which a system operator and/or any other personnel associated with the process control system can interact to view and/or change process control-related information. Once configured, the display layout (i.e., the arrangement of panels, the selection of the types of panels, the association or assignment of runtime applications to particular

panels, etc.) may be proliferated throughout the process control system to increase the intuitiveness of users' interactions with the user interface, thereby reducing training time, minimizing mistakes or operator errors, etc.

**[0064]** Also, generally, the display panels composing the framework 500 may be fixed panels or floating panels. Fixed panels are always visible regardless of whether they have content, have a substantially fixed location within the framework 500, and do not overlap other panels. Thus, the fixed panels within the framework 500 effectively form a background surface of an instance of the runtime workspace 304 (FIG. 3). However, as described in greater detail below, some fixed panels may be movable (or the contents thereof may be copied) to locations occupied by other fixed panels.

**[0065]** In contrast, floating panels provide a temporary content window that may float over, overlap, totally or partially occlude, or otherwise interfere with the viewing of one or more fixed panels or other floating panels. Floating panels may be used to display, for example, a process control-related faceplate, runtime application user-specific interface components, etc. Additionally, as described in greater detail below, floating panels may be configured to be movable within the framework 500 to enable a system operator to view panels or portions thereof that may be occluded by the floating panels. Unlike fixed panels, floating panels can be closed by the system operator when viewing of the content of the floating panel is no longer needed or desired.

**[0066]** Turning in detail to the workspace framework 500 of FIG. 5, the upper and lower portions of the framework 500 are bordered by fixed panels 502 and 504. The fixed panels 502 and 504 have an elongate rectangular shape and, thus, may be well-suited for displaying alarm information (e.g., alarm banners), selection areas for

selecting actions, operations, etc., status information banners (e.g., process control area status banners), or any other process control-related information. The workspace 500 also includes stackable panels 506 and 508, which are similar to the fixed panels 502 and 504 except that the stackable panels 506 and 508 are layered on the fixed panels 502 and 504. Like the fixed panels 502 and 504, the stackable panels 506 and 508 may be used to display alarm information, status information, toolbars, etc.

**[0067]** The workspace 500 also includes a central display area 510 that is composed of a plurality of display panels 512, 514, 516, 518, and 520. Each of the panels 512-520 may contain content from different runtime time applications. Alternatively or additionally, some or all of the panels 512-520 may contain information relating to different types of information provided by a single runtime application. For example, each of the panels 512-520 may contain process control information relating to different areas or portions of a single process control plant. Further, some or all of the panels 512-520 may contain information pertaining to live process control information and may enable users to manipulate process parameters and the like. Alternatively or additionally, one or more of the panels 512-520 may contain process control plant-related documentation, which may be annotated with live process control information.

**[0068]** The example workspace 500 also includes a floating panel 522, which in this example is overlapping the panels 508, 512, 514, and 518. The floating panel 522 may include content such as, for example, pop-up dialogs, faceplates, etc.

**[0069]** The number, types, and arrangement of panels composing the example workspace 500 of FIG. 5 is only one example and, thus, any other combination and/or arrangement of panels could be used instead. Further, although the example runtime workspace 500 and the panels 502-522 composing the workspace 500 are depicted as

having a rectangular geometry, any other geometry or combination of geometries could be used instead of or in addition to those depicted in the example of FIG. 5.

[0070] FIGS. 6 and 7 depict an example manner in which one or more display panels may be moved within a display generated by the example integrated graphical runtime interface described herein. More specifically FIG. 6 depicts a display area 600 (similar to the display area 510 of FIG. 5) composed of display areas 601, 602, 603, 604, and 605, which correspond to respective display panels DP1, DP0, DP2, DP3, and DP4. If desired, a system operator or other user may select (e.g., using a mouse or other pointing device) and move the display panel DP3 to reside at the location of the display area 605. After the display panel DP3 has been moved to the location 605, the previous location occupied by the display area 604 may be blank or empty. Of course, any of the panels DP0, DP1, DP2, DP3, and DP4 could be moved to reside in the location of any other panel.

[0071] FIGS. 8 and 9 depict an example manner in which one or more display panels may be copied within a display generated by the example integrated graphical runtime interface described herein. As shown in FIG. 8, a system operator or other user may elect to copy the display panel DP1 to the display panel DP2. Following the copy operation as shown in FIG. 9, the display panels DP1 and DP2 share the display panel location 603 and the display panel DP1 also remains in its original location.

[0072] FIG. 10 is an example display panel assignment process 1000 that may be used by the example integrated graphical runtime interface described herein. Before discussing the example process 1000 in detail, a brief discussion relating to the manner in which workspace display definitions may be configured to enable the operation of the panel assignment process 1000 is provided below.

[0073] In general, each of the panels to be used within a workspace framework (e.g., the workspace framework 500 of FIG. 5) may be configured to be associated with one or more display category names (e.g., content categories). For example, returning to the example of FIG. 5, the display panel 512 may be configured to be associated with live process control data and historical process control data, and the display panel 502 may be configured to be associated with only alarm or event data. Likewise, each of the remaining panels 504, 506, 508, 514, 516, 518, 520, and 522 may also be configured to be associated with one or more display or content categories. Further, one of the panels 502-522 shown in the example framework 500 of FIG. 5 may be designated as a default panel which, as described below, may be used to render display information for which other destination identifying information is not available.

[0074] Additionally, each of the panels 502-522 is associated with identifying destination or location information and a use precedence. The destination or location information corresponds to a physical location within the workspace display at which information for that panel should be rendered. In the case of a floating panel, the location information may correspond to an initial or default physical location within the workspace display. As described in greater detail below, the use precedence information may be used to resolve in which of a plurality of available panels content should be rendered absent instruction(s) indicating that content should be rendered in a particular panel.

[0075] The initial display location of floating panels within the workspace 500 (e.g., the floating panel 522) may be configured by setting, for each floating panel, an anchor point (e.g., a physical location within the workspace 500) at which a predetermined portion (e.g., a corner) of the panel is to be placed. Alternatively or

additionally, selected locations or anchor points distributed over the physical display surface associated with the workspace 500 may be associated with different content categories. In those cases, instantiation of a floating panel containing a first type or category of content may be placed at one (or one of a plurality) of anchor points associated with the type or category of content in the floating panel.

[0076] The preferred initial size(s) or dimensions of each floating panel may also be configured. For example, the floating panel may be configured to establish its initial size based on the native size of the display device on which the floating panel is to be rendered. In another example, the floating panel may be configured to establish its initial size based on a user-defined preferred size. Alternatively or additionally, each floating panel may be configured to enable or prevent a user from resizing the panel. In the case where the floating panel is configured to be resizable, the floating panel may be rendered with a border suitable for use in windows resizing operations.

[0077] Now turning in detail to FIG. 10, the example process 1000 determines whether it has received a request to render a new display (block 1002). If a request to render a new display has been received at block 1002, the process 1000 determines whether a destination panel for the display has been specified (block 1004). If a destination panel has not been specified at block 1004, then the example process 1000 compares the category or categories associated with the display to be rendered to the categories associated with each of available display panels (block 1006). The example process 1000 then determines whether the categories associated with the display match any of the categories associated with the available display panels (block 1008). If the process 1000 determines at block 1008 that none of the categories associated with the display to be rendered match those of available display panels or if

the display to be rendered does not include any category information, then the display is assigned to be rendered in the default panel (block 1010).

**[0078]** On the other hand, if the example process 1000 determines at block 1008 that there are matches, then the process 1000 determines whether there are multiple category matches (block 1012). If the process 1000 determines that there are not multiple category matches at block 1012 (i.e., there is only one match), then the example process 1000 assigns the display to be rendered in the matching panel, which may be a fixed or floating panel (block 1014).

**[0079]** If the process 1000 determines at block 1012 that there are multiple available display panels having at least one category that matches at least one category associated with the display then the process 1000 assigns the display to be rendered in one of the matching panels based on a predetermined use order associated with the matching panels (block 1016).

**[0080]** One manner of assigning panels at block 1016 may follow the selection sequence outlined below. First, if possible, the process 1000 assigns the display to a matching fixed panel that is currently without content (e.g., a fixed panel that is blank or unused). If more than one such matching fixed panel exists, then the process selects one of the panels based on the use order of the panels. Second, if there are no matching fixed panels currently without content, then the process 1000 assigns the display to a matching floating panel that is currently closed. Once assigned, the assigned floating panel is opened and the display content is rendered therein. If more than one such floating panel is available, then the process 1000 selects one of the panels based on the use order of the panels. Third, if there are no matching currently closed floating panels, the process 1000 determines if there is a matching currently open floating panel. If more than one currently open floating panel matches, then the

process 1000 identifies the open floating panel containing the oldest content and replaces the content of that panel with the new display content. Fourth, if the process 1000 determines that there are no matching currently open floating panels, then the process 1000 determines if there are any matching currently used fixed panels and assigns the new display content to a matching currently used fixed panel. If there is more than one matching currently used fixed panel, then the process 1000 assigns the new display content to one of the matching currently used fixed panels based on the use order of those panels. Alternatively or additionally, the process 1000 may enable a user to manually select in which panel a new display is to be rendered.

**[0081]** The functional blocks or operations described herein may be implemented using any desired combination of software, firmware and hardware. For example, one or more microprocessors, microcontrollers, application specific integrated circuits (ASICs), etc. may access instructions or data stored on machine or processor accessible storage media to carry out the methods and to implement the apparatus described herein. The storage media may include any combination of devices and/or media such as, for example, solid state storage media including random access memory (RAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), etc., optical storage media, magnetic storage media, etc. In addition, software used to implement the functional blocks may additionally or alternatively be delivered to and accessed by the processor or other device or devices executing the software via the Internet, telephone lines, satellite communications, etc.

**[0082]** FIG. 11 depicts an example processor system 1102 that may be used to implement the apparatus and methods described herein. The example processor-based system 1102 may be, for example, a server, a personal computer, or any other type of computing device.

[0083] The processor 1100 may, for example, be implemented using one or more Intel® microprocessors from the Pentium® family, the Itanium® family or the XScale® family. Of course, other processors from other families are also appropriate. The processor 1100 is in communication with a main memory including a volatile memory 1104 and a non-volatile memory 1106 via a bus 1108. The volatile memory 1104 may be implemented by Synchronous Dynamic Random Access Memory (SDRAM), Dynamic Random Access Memory (DRAM), RAMBUS Dynamic Random Access Memory (RDRAM) and/or any other type of random access memory device. The non-volatile memory 1106 may be implemented by flash memory and/or any other desired type of non-volatile memory device. Access to the memory 1104 is typically controlled by a memory controller (not shown) in a conventional manner.

[0084] The system 1102 also includes an interface circuit 1110. The interface circuit 1110 may be implemented by any type of well-known interface standard to, for example, enable the system 1102 to communicate via one or more of the links 24, 32, 40, 42, 46, and 48 of FIG. 1.

[0085] The system 1102 also includes one or more mass storage devices 1118 for storing software and/or data. Examples of such mass storage devices include floppy disk drives, hard drive disks, compact disk drives and digital versatile disk (DVD) drives.

[0086] Although certain methods and apparatus and articles of manufacture have been described herein, the scope of coverage of this patent is not limited thereto. To the contrary, this patent covers all methods, apparatus and articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents.

What is claimed is:

1. A method of displaying process control information via a graphical user interface, comprising:

instantiating a runtime workspace application to operatively interpose between an operator station operating system and a user;

displaying a plurality of panels via the graphical user interface; and

displaying a portion of the process control information associated with a runtime application in at least one of the plurality of panels via the runtime workspace application.

2. A method as defined in claim 1, further comprising preventing via the runtime workspace application a particular user input to the operator station associated with the runtime application from affecting the operating system.

3. A method as defined in claim 2, wherein preventing via the runtime workspace application the particular user input to the operator station from affecting the operating system comprises trapping or interrupting one or more keystrokes associated with an operating system command.

4. A method as defined in claim 1, wherein displaying the plurality of panels comprises displaying at least one of a fixed panel and a floating panel.

5. A method as defined in claim 1, wherein displaying the portion of the process control information associated with the runtime application in the at least one of the plurality of panels comprises assigning the portion of the process control information to the at least one of the plurality of panels based on a content category associated with the portion of the process control information.

6. A method as defined in claim 1, wherein the runtime application comprises at least one of a trending application, a batch processing application, an advanced control application, an alarms application, or a process graphics application.

7. A method as defined in claim 1, wherein the operator station operating system comprises a windows-based operating system.

8. A system for displaying process control information via a graphical user interface, comprising:

a processor coupled to a memory and programmed to:

instantiate a runtime workspace application to operatively interpose between an operator station operating system and a user;

display a plurality of panels via the graphical user interface; and

display a portion of the process control information associated with a runtime application in at least one of the plurality of panels via the runtime workspace application.

9. A system as defined in claim 8, wherein the processor is programmed to prevent via the runtime workspace application a particular user input to the operator station associated with the runtime application from affecting the operating system.

10. A system as defined in claim 9, wherein the processor is programmed to prevent via the runtime workspace application the particular user input to the operator station from affecting the operating system by trapping or interrupting one or more keystrokes associated with an operating system command.

11. A system as defined in claim 8, wherein the processor is programmed to display the plurality of panels by displaying at least one of a fixed panel and a floating panel.

12. A system as defined in claim 8, wherein the processor is programmed to display the portion of the process control information associated with the runtime application in the at least one of the plurality of panels by assigning the portion of the process control information to the at least one of the plurality of panels based on a content category associated with the portion of the process control information.

13. A system as defined in claim 8, wherein the runtime application comprises at least one of a trending application, a batch processing application, an advanced control application, an alarms application, or a process graphics application.

14. A system as defined in claim 8, wherein the operator station operating system comprises a windows-based operating system.

15. A machine readable medium having instructions stored thereon that, when executed, cause a machine to:

instantiate a runtime workspace application to operatively interpose between an operator station operating system and a user;

display a plurality of panels via the graphical user interface; and

display a portion of process control information associated with the runtime application in at least one of the plurality of panels via the runtime workspace application.

16. A machine readable medium as defined in claim 15 having instructions stored thereon that, when executed, cause the machine to prevent via the runtime workspace application a particular user input to the operator station associated with the runtime application from affecting the operating system.

17. A machine readable medium as defined in claim 16, wherein the instructions, when executed, cause the machine to prevent via the runtime workspace application the particular user input to the operator station from affecting the operating system by

trapping or interrupting one or more keystrokes associated with an operating system command.

18. A machine readable medium as defined in claim 15, wherein the instructions, when executed, cause the machine to display the plurality of panels by displaying at least one of a fixed panel and a floating panel.

19. A machine readable medium as defined in claim 15, wherein the instructions, when executed, cause the machine to display the portion of the process control information associated with the runtime application in the at least one of the plurality of panels by assigning the portion of the process control information to the at least one of the plurality of panels based on a content category associated with the portion of the process control information.

20. A machine readable medium as defined in claim 15, wherein the runtime application comprises at least one of a trending application, a batch processing application, an advanced control application, an alarms application, or a process graphics application.

21. A machine readable medium as defined in claim 15, wherein the operator station operating system comprises a windows-based operating system.

22. A method of displaying process control information via a graphical user interface, comprising:

establishing a workspace framework having a plurality of display panels;

assigning display category information to each of the display panels;

assigning a category to process control information to be displayed;

comparing the category assigned to the process control information to be displayed to the category information assigned to the display panels; and

selecting one of the display panels to display the process control information to be displayed based on the comparison.

23. A method as defined in claim 22, wherein establishing the workspace framework having the plurality of display panels comprises establishing a collection of fixed panels arranged to be displayed via a rectangular display.

24. A method as defined in claim 23, wherein establishing the workspace framework having the plurality of display panels comprises establishing at least one floating panel to be displayed to cover at least a portion of at least one of the fixed panels.

25. A method as defined in claim 22, wherein assigning the display category information to each of the display panels comprises assigning at least one of a plurality of content categories to each of the display panels.

26. A method as defined in claim 22, further comprising assigning use order information to each of the display panels, and wherein selecting the one of the display panels to display the process control information to be displayed comprises selecting one of a plurality of panels having category information matching the category assigned to the process control information to be displayed based on the use order information assigned to the selected one of the plurality of panels.

27. A method as defined in claim 22, wherein selecting the one of the display panels to display the process control information to be displayed based on the comparison comprises selecting the one of the display panels based on the types of the display panels.

28. A method as defined in claim 27, wherein the types of the display panels comprise a fixed panel type and a floating panel type.

29. A system for displaying process control information via a graphical user interface, comprising:

a processor coupled to a memory and programmed to:

establish a workspace framework having a plurality of display panels;

assigning display category information to each of the display panels;

assign a category to process control information to be displayed;

compare the category assigned to the process control information to be displayed to the category information assigned to the display panels; and

select one of the display panels to display the process control information to be displayed based on the comparison.

30. A system as defined in claim 29, wherein the processor is programmed to establish the workspace framework having the plurality of display panels by establishing a collection of fixed panels arranged to be displayed via a rectangular display.

31. A system as defined in claim 30, wherein the processor is programmed to establish the workspace framework having the plurality of display panels by establishing at least one floating panel to be displayed to cover at least a portion of at least one of the fixed panels.

32. A system as defined in claim 29, wherein the processor is programmed to assign the display category information to each of the display panels by assigning at least one of a plurality of content categories to each of the display panels.

33. A system as defined in claim 29, wherein the processor is programmed to assign use order information to each of the display panels, and wherein the processor is programmed to select the one of the display panels to display the process control information to be displayed by selecting one of a plurality of panels having category

information matching the category assigned to the process control information to be displayed based on the use order information assigned to the selected one of the plurality of panels.

34. A system as defined in claim 29, wherein the processor is programmed to select the one of the display panels to display the process control information to be displayed based on the comparison by selecting the one of the display panels based on the types of the display panels.

35. A system as defined in claim 34, wherein the types of the display panels comprise a fixed panel type and a floating panel type.

36. A machine readable medium having instructions stored thereon that, when executed, cause the machine to:

establish a workspace framework having a plurality of display panels;

assign display category information to each of the display panels;

assign a category to process control information to be displayed;

compare the category assigned to the process control information to be displayed to the category information assigned to the display panels; and

select one of the display panels to display the process control information to be displayed based on the comparison.

37. A machine readable medium as defined in claim 36, wherein the instructions, when executed, cause the machine to establish the workspace framework having the plurality of display panels by establishing a collection of fixed panels arranged to be displayed via a rectangular display.

38. A machine readable medium as defined in claim 37, wherein the instructions, when executed, cause the machine to establish the workspace framework having the

plurality of display panels by establishing at least one floating panel to be displayed to cover at least a portion of at least one of the fixed panels.

39. A machine readable medium as defined in claim 36, wherein the instructions, when executed, cause the machine to assign the display category information to each of the display panels by assigning at least one of a plurality of content categories to each of the display panels.

40. A machine readable medium as defined in claim 36 having instructions stored thereon that, when executed, cause the machine to assign use order information to each of the display panels, and wherein the instructions, when executed, cause the machine to select the one of the display panels to display the process control information to be displayed by selecting one of a plurality of panels having category information matching the category assigned to the process control information to be displayed based on the use order information assigned to the selected one of the plurality of panels.

41. A machine readable medium as defined in claim 36, wherein the instructions, when executed, cause the machine to select the one of the display panels to display the process control information to be displayed based on the comparison by selecting the one of the display panels based on the types of the display panels.

42. A method as defined in claim 27, wherein the types of the display panels comprise a fixed panel type and a floating panel type.

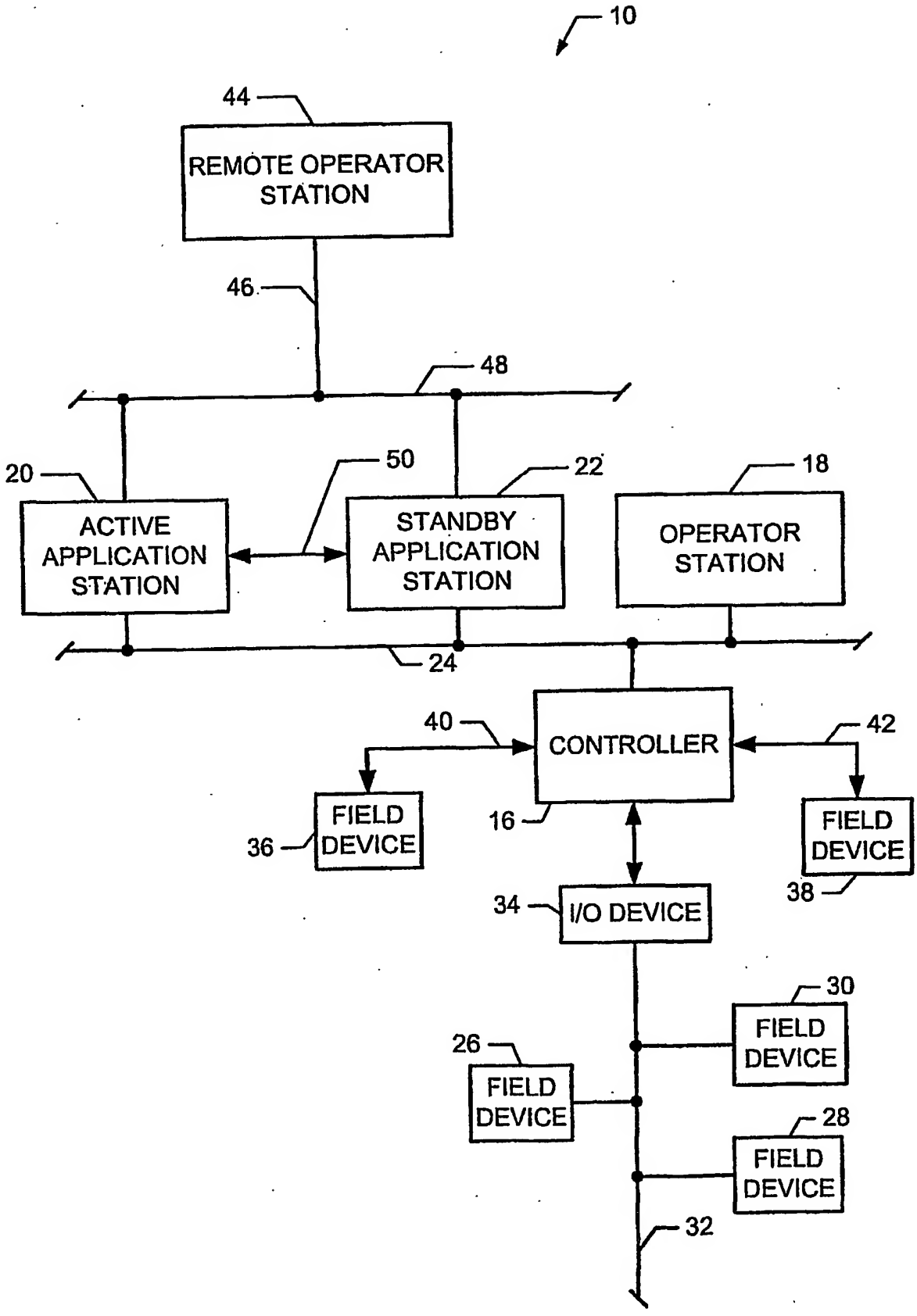
10
44
REMOTE OPERATOR STATION
46
48
20
50
22
18
ACTIVE APPLICATION STATION
STANDBY APPLICATION STATION
OPERATOR STATION
24
40
CONTROLLER
42
FIELD DEVICE
36
16
FIELD DEVICE
38
34
I/O DEVICE
30
FIELD DEVICE
26
FIELD DEVICE
28
FIELD DEVICE
32

FIG. 1

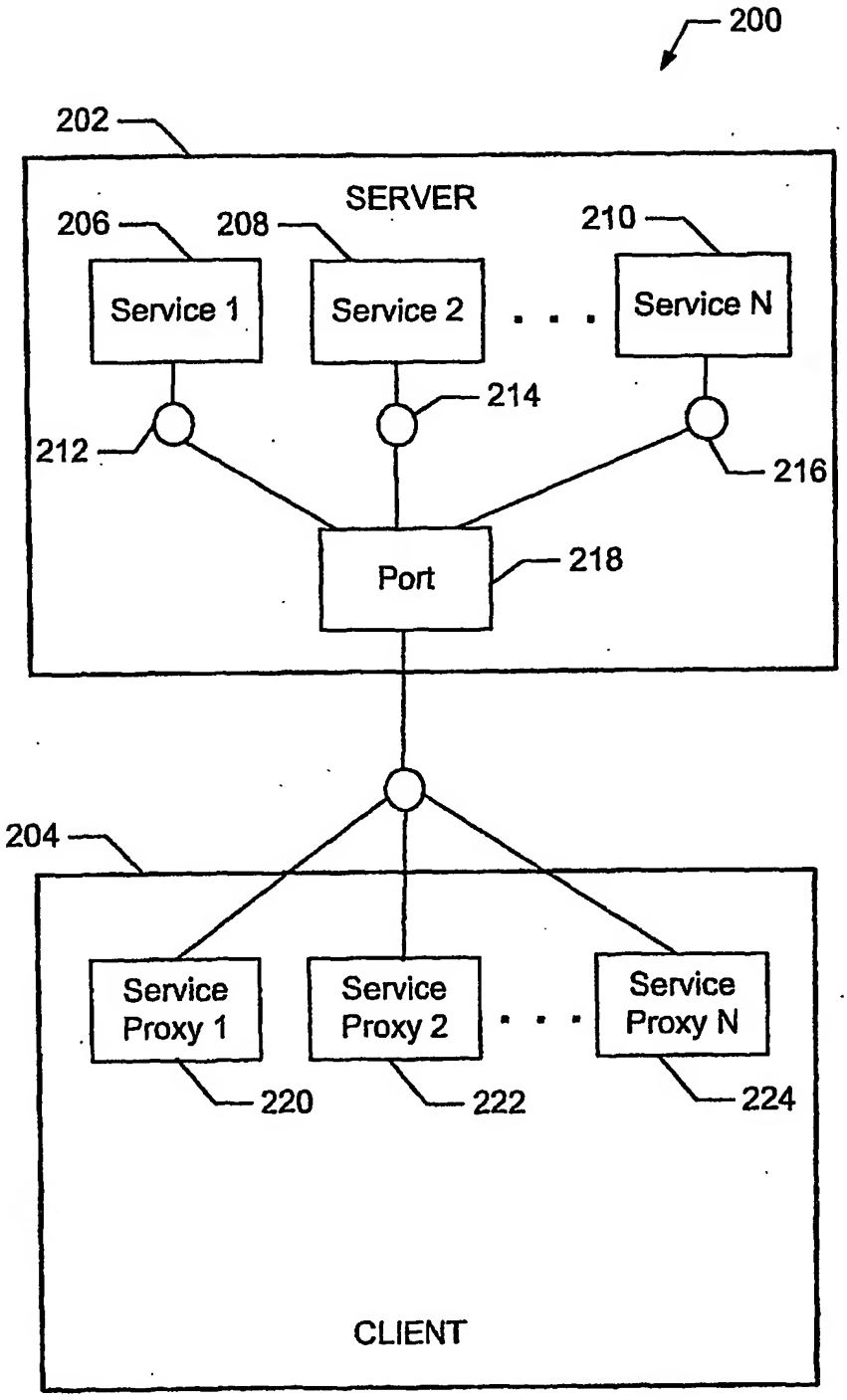
200
202
SERVER
206
208
210
Service 1
Service 2
Service N
214
212
216
Port
218
204
Service Proxy 1
Service Proxy 2
Service Proxy N
220
222
224
CLIENT

FIG. 2

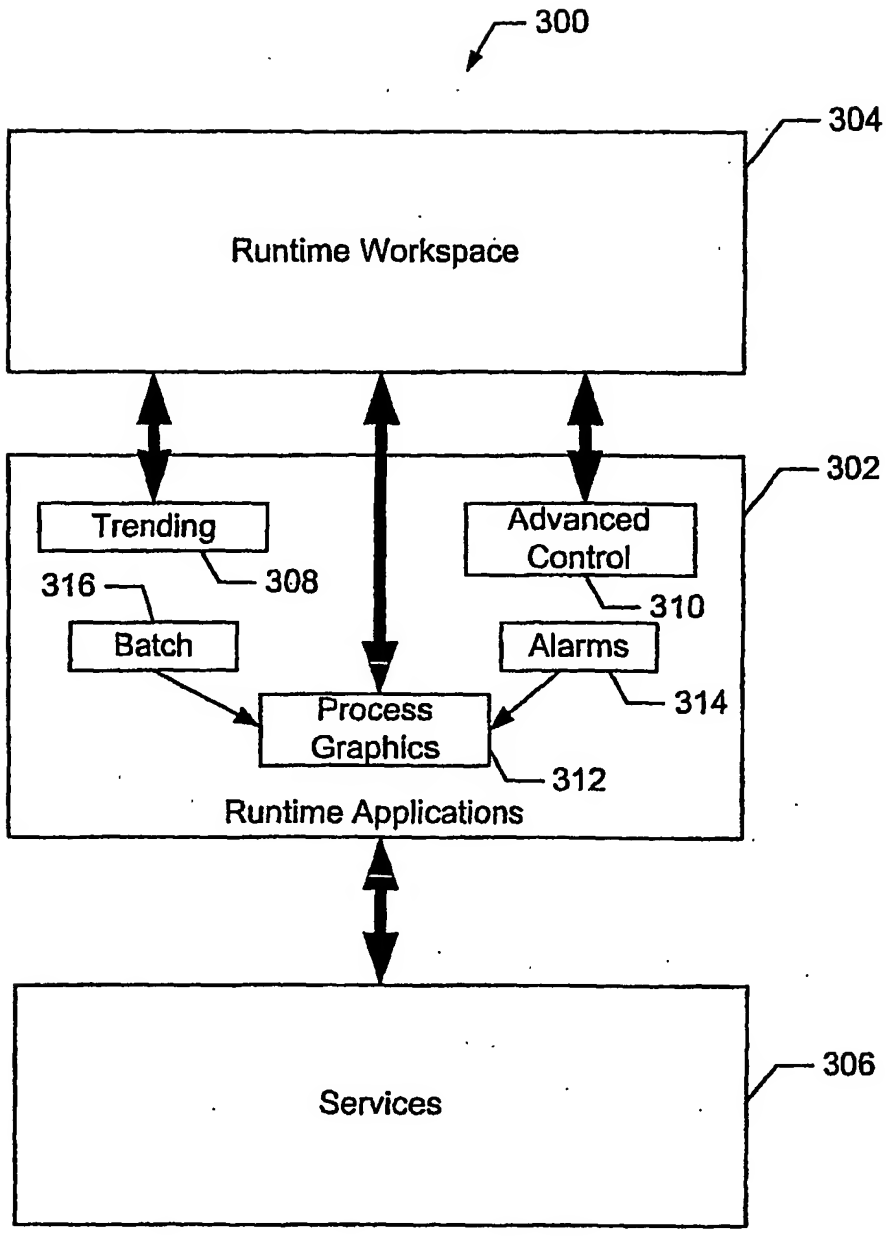
300
304
Runtime Workspace
302
Trending
308
316
Batch
Advanced Control
310
Alarms
314
Process Graphics
312
Runtime Applications
306
Services

FIG. 3

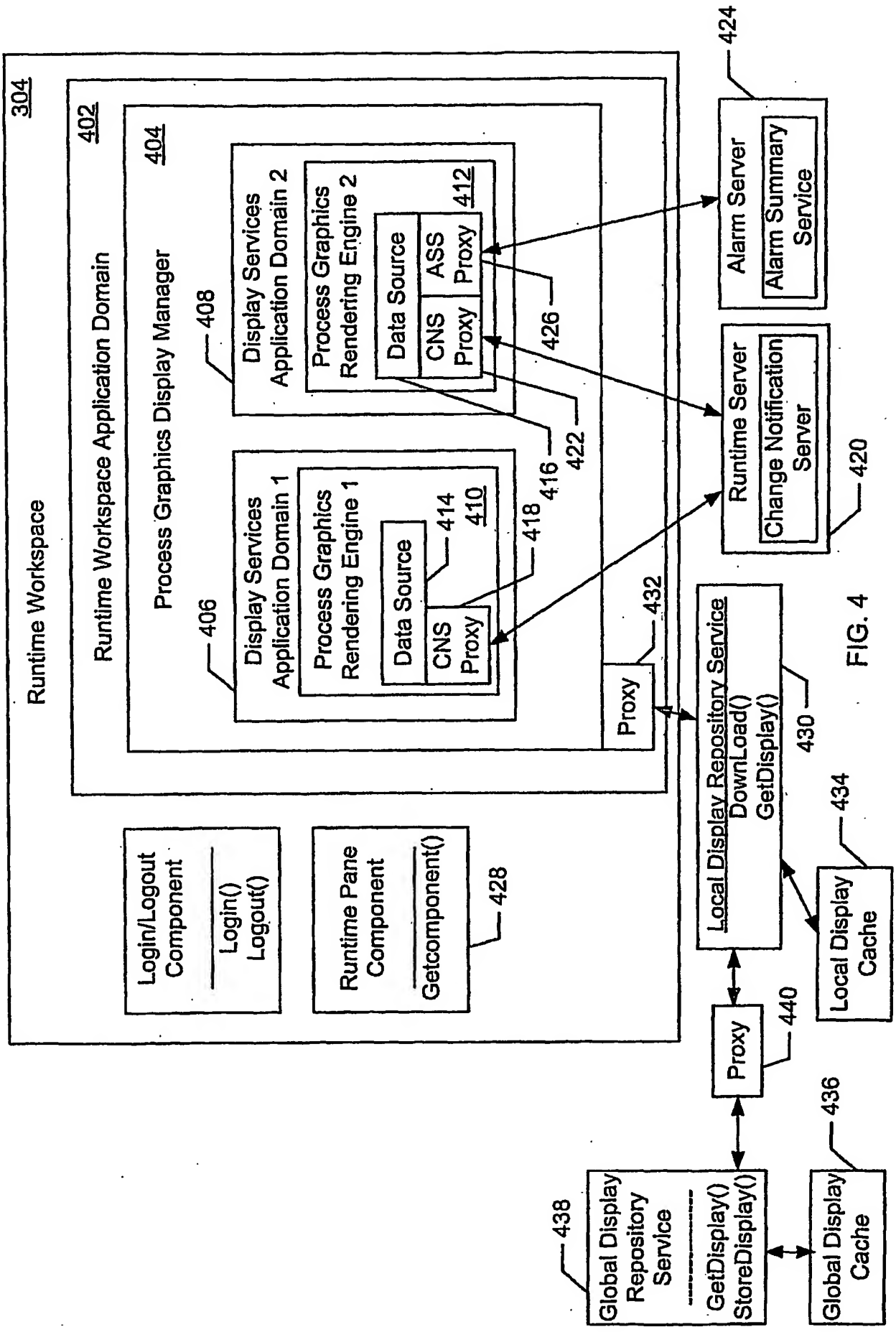
304
Runtime Workspace
402
Runtime Workspace Application Domain
404
Process Graphics Display Manager
406
Display Services Application Domain 1
Process Graphics Rendering Engine 1
Data Source
CNS Proxy
414
410
418
416
408
Display Services Application Domain 2
Process Graphics Rendering Engine 2
Data Source
CNS Proxy
ASS Proxy
412
422
426
Proxy
432
Login/Logout Component
Login()
Logout()
Runtime Pane Component
Getcomponent()
428
Local Display Repository Service
DownLoad()
GetDisplay()
430
Alarm Server
Alarm Summary Service
424
Runtime Server
Change Notification Server
420
Proxy
440
Local Display Cache
434
Global Display Repository Service
GetDisplay()
StoreDisplay()
438
Global Display Cache
436

FIG. 4

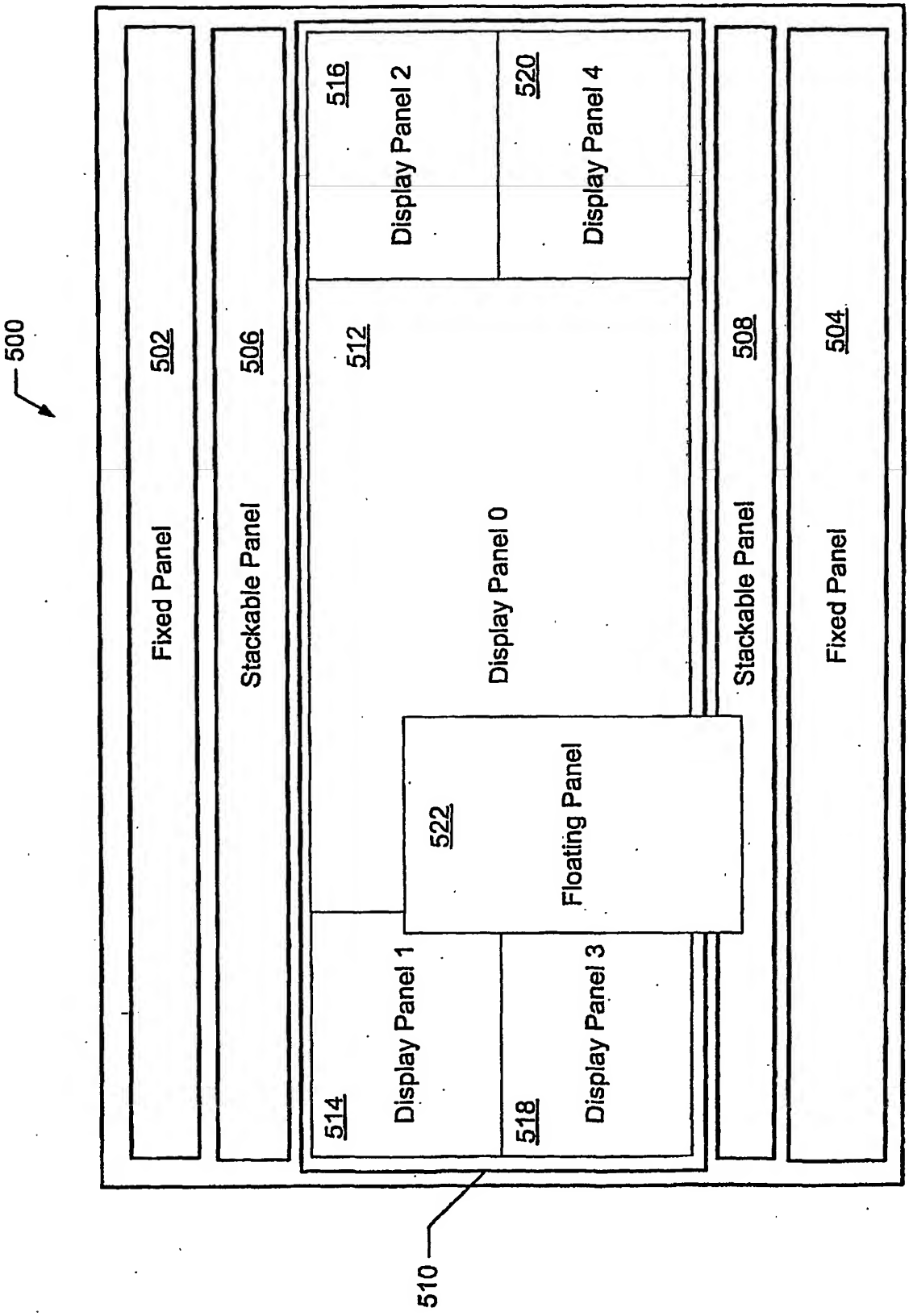
500
Fixed Panel
502
Stackable Panel
506
512
Display Panel 0
516
Display Panel 2
520
Display Panel 4
514
Display Panel 1
518
Display Panel 3
522
Floating Panel
508
Stackable Panel
504
Fixed Panel
510

FIG. 5

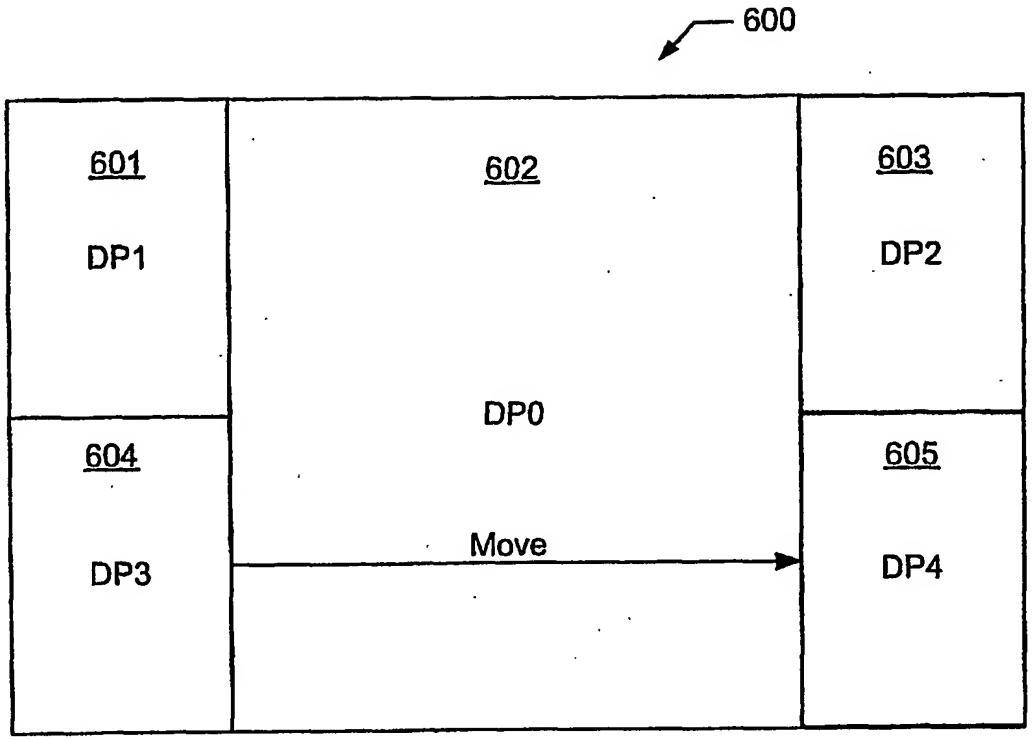
600
601
DP1
602
DP0
603
DP2
604
DP3
Move
605
DP4

FIG. 6

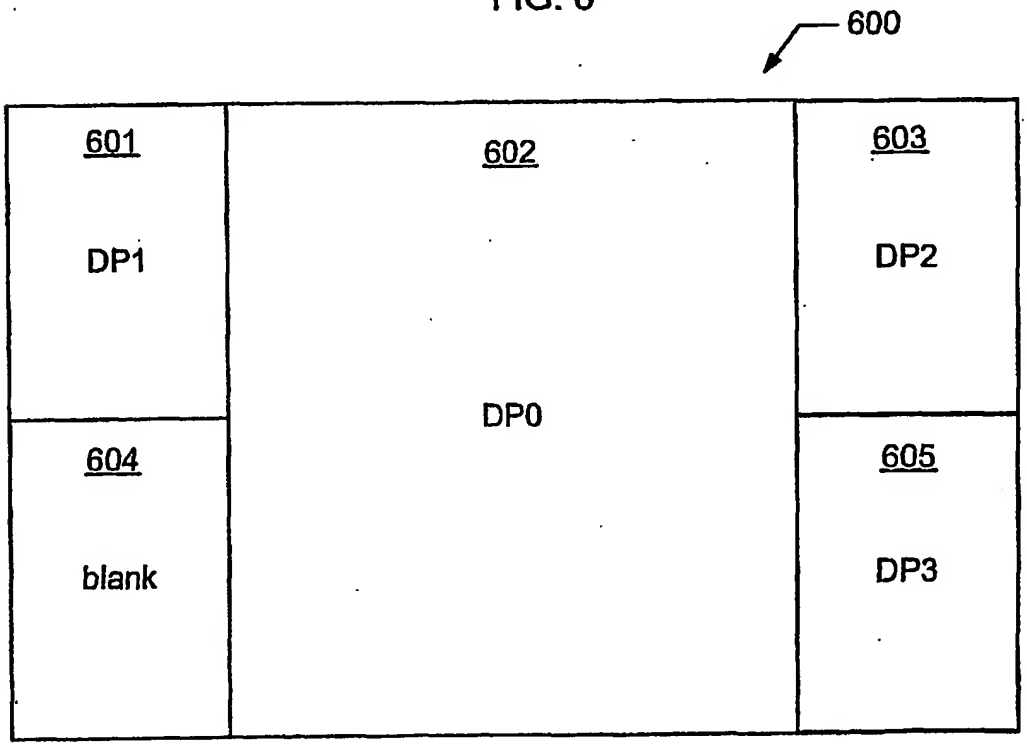
600
601
DP1
602
DP0
603
DP2
604
blank
605
DP3

FIG. 7

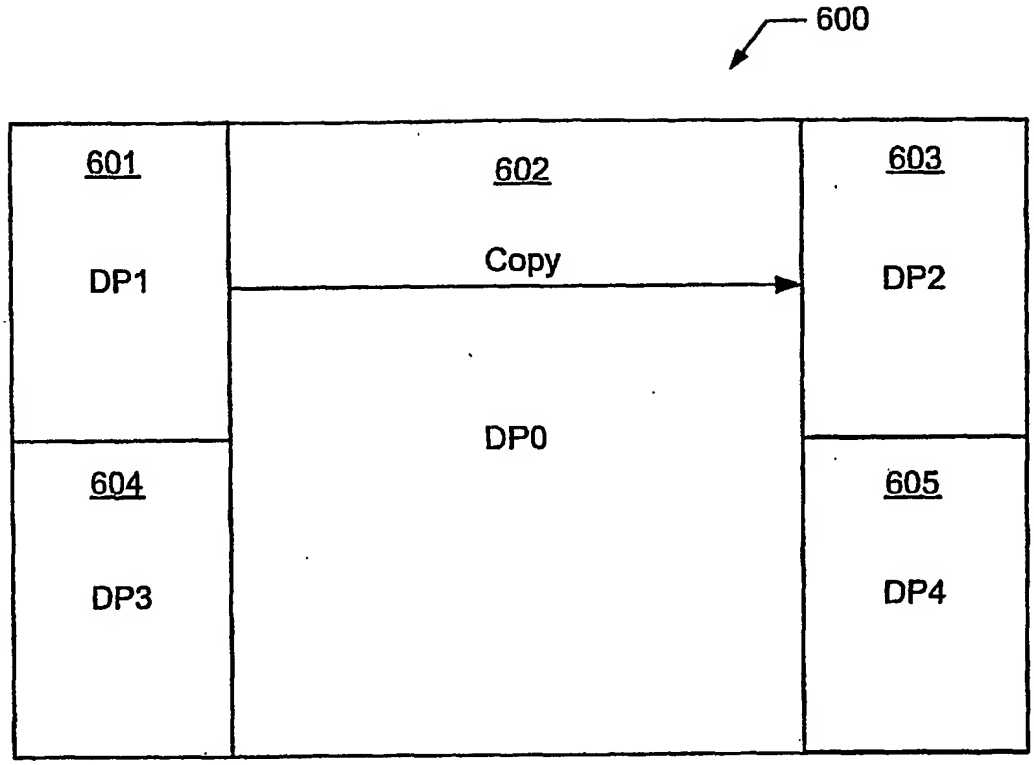
600
601
DP1
602
Copy
603
DP2
DP0
604
DP3
605
DP4

FIG. 8

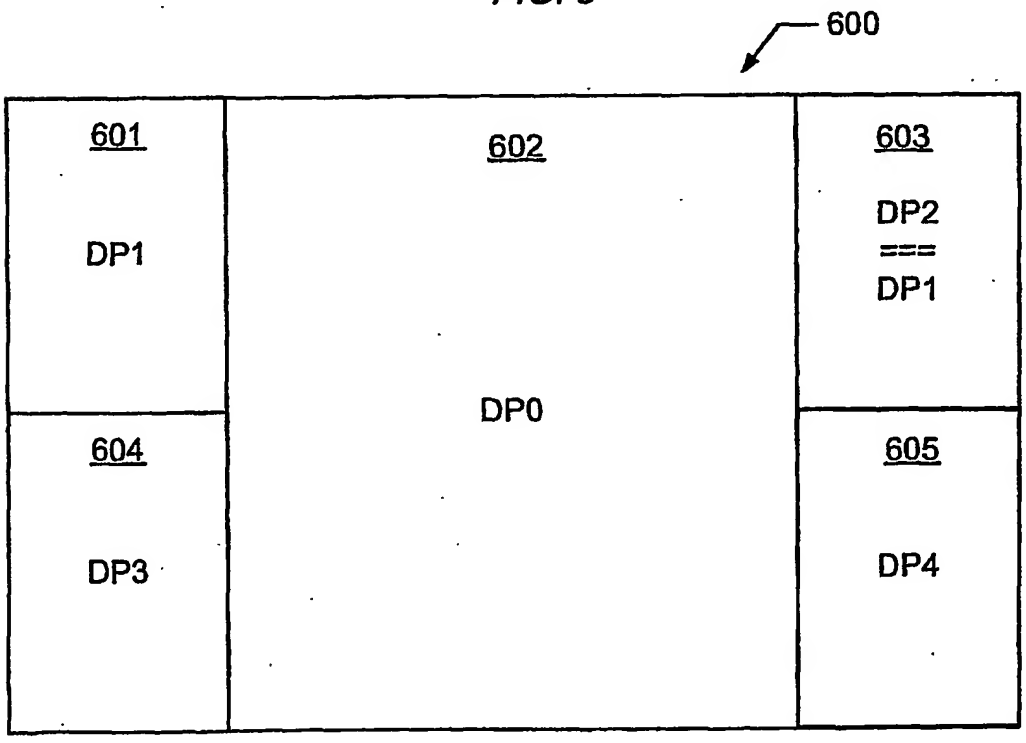
600
601
DP1
602
603
DP2
===
DP1
DP0
604
DP3
605
DP4

FIG. 9

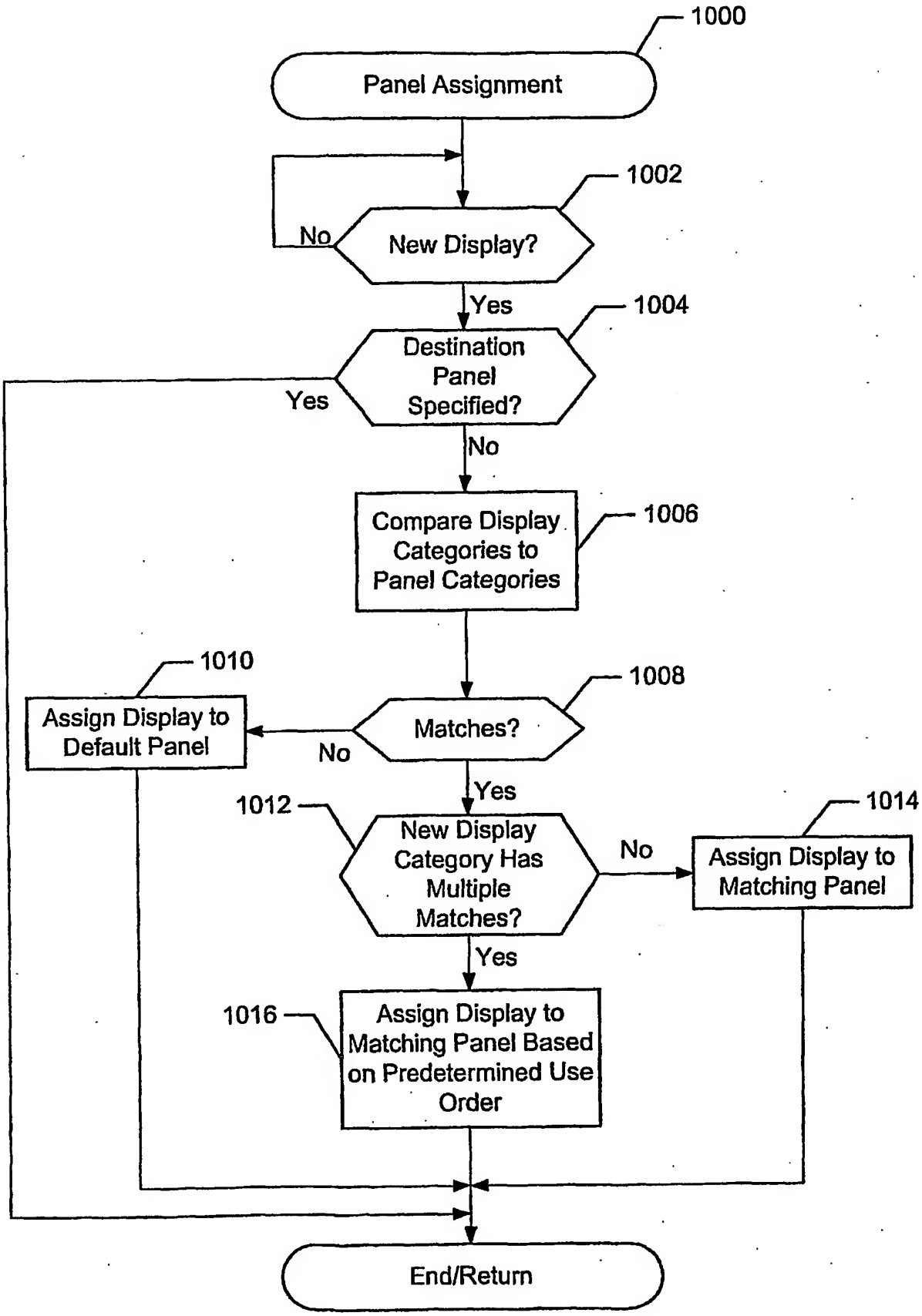
1000
Panel Assignment
1002
No
New Display?
Yes
1004
Destination Panel Specified?
Yes
No
Compare Display Categories to Panel Categories
1006
1010
Assign Display to Default Panel
1008
Matches?
No
Yes
1012
New Display Category Has Multiple Matches?
No
1014
Assign Display to Matching Panel
Yes
1016
Assign Display to Matching Panel Based on Predetermined Use Order
End/Return

FIG. 10

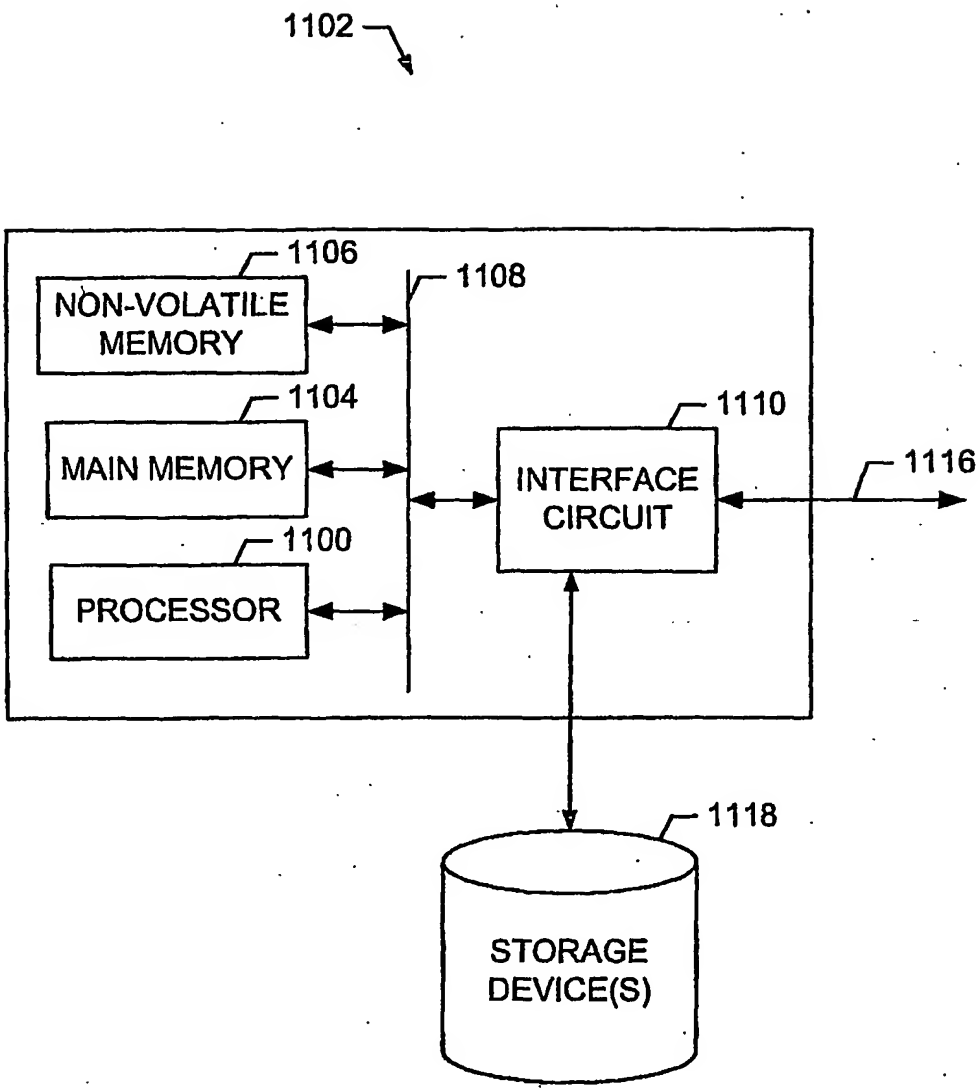
1102
1106
NON-VOLATILE MEMORY
1108
1104
MAIN MEMORY
1110
INTERFACE CIRCUIT
1116
1100
PROCESSOR
1118
STORAGE DEVICE(S)

FIG. 11

# INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT/US2005/015439

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05B19/042

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 5 631 825 A (VAN WEELE ET AL)<br>20 May 1997 (1997-05-20)<br>column 1 - column 45; figures 1-5 | 1,8,15 |
| X | US 2002/055790 A1 (HAVEKOST ROBERT B)<br>9 May 2002 (2002-05-09)<br>page 1 - page 14; figures 1-11 | 1,8,15,<br>22,29,36 |
| A | US 2003/028269 A1 (SPRIGGS BOB ET AL)<br>6 February 2003 (2003-02-06)<br>the whole document | 1-42 |
| A | US 5 611 059 A (BENTON ET AL)<br>11 March 1997 (1997-03-11)<br>the whole document | 1-42 |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 1 August 2005 | 10/08/2005 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Morrish, I. |

# INTERNATIONAL SEARCH REPORT

In tional application No.
PCT/US2005/015439

## Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1,8,15

   DIsplaying information associated with runtime application

   ---

2. claims: 22,29,36

   assigning category inforamation to information to be displayed

   ---

# INTERNATIONAL SEARCH REPORT

nation on patent family members

Inter al Application No
PCT/US2005/015439

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 5631825 A | 20-05-1997 | AU 7657194 A | 18-04-1995 |
| | | CA 2172063 A1 | 06-04-1995 |
| | | DE 69424558 D1 | 21-06-2000 |
| | | DE 69424558 T2 | 15-02-2001 |
| | | WO 9509387 A1 | 06-04-1995 |
| | | EP 0721611 A1 | 17-07-1996 |
| | | ES 2145837 T3 | 16-07-2000 |
| | | JP 9503086 T | 25-03-1997 |
| US 2002055790 A1 | 09-05-2002 | US 6774786 B1 | 10-08-2004 |
| | | DE 10217107 A1 | 28-11-2002 |
| | | GB 2377070 A ,B | 31-12-2002 |
| | | HK 1051428 A1 | 01-04-2005 |
| | | JP 2003005830 A | 08-01-2003 |
| | | DE 10154534 A1 | 27-06-2002 |
| | | GB 2372365 A ,B | 21-08-2002 |
| | | JP 2002222012 A | 09-08-2002 |
| | | US 2005012608 A1 | 20-01-2005 |
| | | US 2002077711 A1 | 20-06-2002 |
| US 2003028269 A1 | 06-02-2003 | US 6421571 B1 | 16-07-2002 |
| | | AU 7209101 A | 12-09-2001 |
| | | CN 1406348 A | 26-03-2003 |
| | | EP 1279074 A1 | 29-01-2003 |
| | | JP 2003525489 T | 26-08-2003 |
| | | WO 0165322 A1 | 07-09-2001 |
| | | US 2003023518 A1 | 30-01-2003 |
| US 5611059 A | 11-03-1997 | CA 2197876 A1 | 14-03-1996 |
| | | DE 69523325 D1 | 22-11-2001 |
| | | DE 69523325 T2 | 27-06-2002 |
| | | EP 0777870 A1 | 11-06-1997 |
| | | JP 10505179 T | 19-05-1998 |
| | | WO 9607957 A1 | 14-03-1996 |
| | | US 5706455 A | 06-01-1998 |
| | | US 5675756 A | 07-10-1997 |
| | | US 5929855 A | 27-07-1999 |

# nfairman

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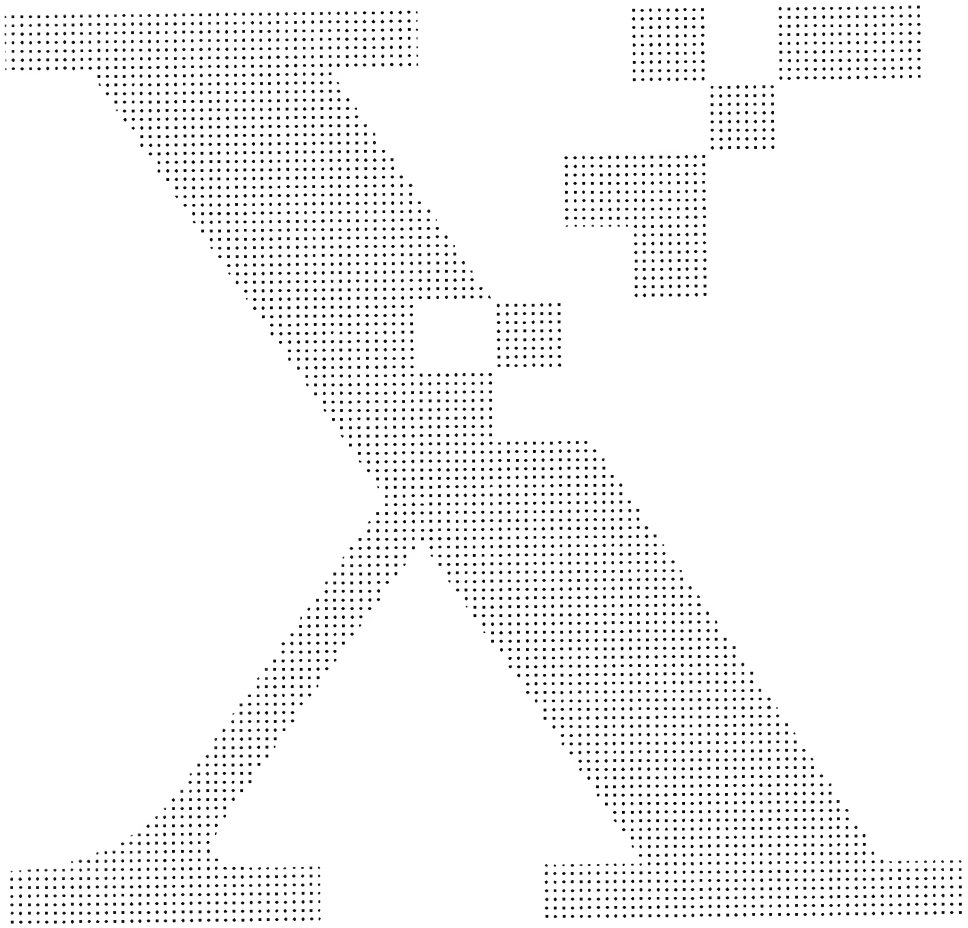

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
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(10) International Publication Number
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(51) International Patent Classification[7]: G05B 19/042

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PCT/US2005/015537

(22) International Filing Date: 4 May 2005 (04.05.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/567,980 4 May 2004 (04.05.2004) US

(71) Applicant *(for all designated States except US)*: **FISHER-ROSEMOUNT SYSTEMS, INC.** [US/US]; 12301 Research Blvd., Research Park Plaza Bldg.111, Austin, TX 78759 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **HAVEKOST, Robert, B.** [US/US]; 146 Westbrook Lane, Elgin, TX 78621 (US). **NIXON, Mark, J.** [US/US]; 1503 Blackjack Drive, Round Rock, TX 78681 (US).

(74) Agent: **HULL, Michael, R.**; Marshall, Gerstein & Borun LLP, 233 S. Wacker Drive, Suite 6300, Sears Tower, Chicago, IL 60606-6357 (US).

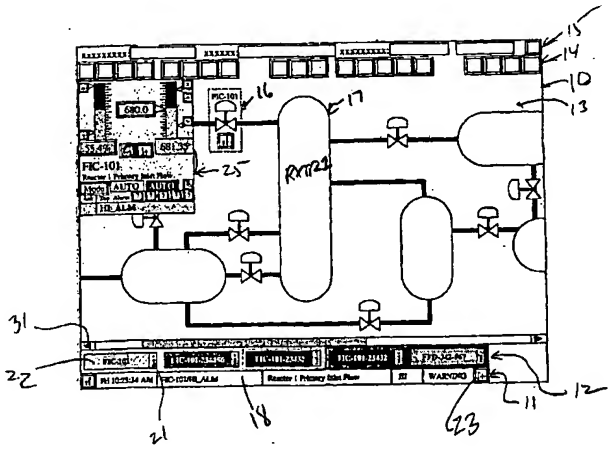
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *with international search report*

*[Continued on next page]*

(54) Title: USER CONFIGURABLE ALARMS AND ALARM TRENDING FOR PROCESS CONTROL SYSTEMS



(57) Abstract: Various graphical displays for plant process operators are provided which combine aspects of alarm priority and alarm age to assist operators in making better choices in responding to alarms. The disclosed graphical displays provide improved contextual information about specific alarms and the relationships with other alarms in the same control module, equipment module, etc. Hierarchically organized presentations of active alarms and alarm age profiles are also provided to assist operators in evaluating causes of "alarm floods" in chain reactions within complex process environments. Various types of alarm or display alerts are also provided for improved monitoring of processed conditions and changes in process controls.

WO 2005/109126 A1

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# USER CONFIGURABLE ALARMS AND ALARM TRENDING FOR PROCESS CONTROL SYSTEMS

## Related Applications

[0001] This application is a regular filed application of and claims, for the purposes of priority, the benefit of U.S. Provisional Application Serial No. 60/567,980, entitled "Graphical User Interface for Representing, Monitoring, and Interacting with Process Control Systems," which was filed on May 4, 2004 and which this application hereby expressly incorporates by reference herein in its entirety. This application is also related to U.S. Patent Application Serial Number 10/625,481, entitled "Integration of Graphic Display Elements, Process Modules and Control Modules in Process Plants," which was filed on July 21, 2003, and which published as U.S. Publication No. 2004/0153804 on August 5, 2004, which, in turn, is a Continuation-in-Part of U.S. Patent Application Serial No. 10/278,469, entitled "Smart Process Modules and Objects in Process Plants," which was filed on October 22, 2002, and which published as U.S. Publication No. 2004/0075689 on April 22, 2004, the entire disclosures of which are hereby expressly incorporated by reference herein in their entirety. This application is also related to U.S. Patent Application Serial Number 10/368,151 entitled "Module Class Objects in a Process Plant Configuration System," which was filed on February 18, 2003, and which published as U.S. Publication No. 2004/0199925 on October 7, 2004, the entire disclosure of which is hereby expressly incorporated by reference herein in its entirety. This application is also related to the following patent applications, which are being filed as International (PCT) applications on the same date as this application and which this application hereby expressly incorporates by reference herein in their entirety: "Associated Graphic Displays in a Process Environment" (Atty. Docket No.

06005/41111); "Integration of Process Modules and Expert Systems in Process Plants" (Atty. Docket No. 06005/41113); "A Process Plant User Interface System Having Customized Process Graphic Display Layers in an Integrated Environment" (06005/41114); "Scripted Graphics in a Process Environment" (Atty. Docket No. 06005/41115); "Graphics Integration into a Process Configuration and Control Environment" (Atty. Docket No. 06005/41116); "Graphic Element with Multiple Visualizations in a Process Environment" (Atty. Docket No. 06005/41117); "System for Configuring Graphic Display Elements and Process Modules in Process Plants (Atty. Docket No. 06005/41118); "Graphic Display Configuration Framework for Unified Process Control System Interface" (Atty. Docket No. 06005/41124); "Markup Language-Based, Dynamic Process Graphics in a Process Plant User Interface" (Atty. Docket No. 06005/41127); "Methods and Apparatus for Modifying Process Control Data" (Atty. Docket Nos. 06005/591622 and 20040/59-11622); "Methods and Apparatus for Accessing Process Control Data" (Atty. Docket Nos. 06005/591623 and 20040/59-11623); "Integrated Graphical Runtime Interface for Process Control Systems" (Atty. Docket Nos. 06005/591628 and 20040/59-11628); "Service-Oriented Architecture for Process Control Systems" (Atty. Docket Nos. 06005/591629 and 20040/59-11629).

## Technical Field

**[0002]** A user interface for a process control system is disclosed. More specifically, a user interface for a process control system is disclosed that enables the operator to modify, configure and manipulate alarm notifications to show alarm priority, alarm age, details about a specific alarm including alarm profiles, as well as perform

alarm trending and superimposing alarm profiles over graphic displays using workstation monitors as well as handheld wireless devices.

## Background of the Related Art

[0003] Process control systems are widely used in factories and/or plants in which products are manufactured or processes are controlled (e.g., chemical manufacturing, power plant control, etc.) Process control systems are also used in the harvesting of natural resources such as, for example, oil and gas drilling and handling processes, etc. Virtually any manufacturing process, resource harvesting process, including agriculture, can be automated through the application of one or more process control systems.

[0004] The manner in which process control systems are implemented has evolved over the years. Older generations of process control systems were typically implemented using dedicated, centralized hardware. However, modem process control systems are typically implemented using a highly distributed network of workstations, intelligent controllers, smart field devices, and the like, some or all of which may perform a portion of an overall process control strategy or scheme. In particular, most modern process control systems include smart field devices and other process control components that are communicatively coupled to each other and/or to one or more controllers via one or more digital data busses. Of course, many of these modern process control systems may also include non-smart field devices such as, for example, 4-20 milliamp (MA) devices, 0-10 volts direct current (VDC) devices, etc., which are typically directly coupled to controllers as opposed to a shared digital data bus or the like.

[0005] In any event, field devices include, for example, input devices (e.g., devices such as sensors that provide status signals that are indicative of process control parameters such as, for example, temperature, pressure, flow rate, etc.), as well as control operators or actuators that perform actions in response to commands received from controllers and/or other field devices. For example, a controller may send signals to a valve to increase pressure or flow, to a heater or chiller to change a temperature, to a mixer to agitate ingredients in a process control system, etc.

[0006] Obviously, in a complicated process system, a large number of different field devices are transmitting data which eventually is presented at an operator's workstation. Further, all of the field devices either directly present "alarms" to an operator's workstation or the signals transmitted by the field devices are interpreted by software which results in an alarm being sent to an operator's workstation. An operator may receive a large number of alarms during a typical shift. Because most process systems are configured so that alarms are sent in advance of the need for a corrective action as opposed to after a serious problem has been created. Therefore, because an operator may receive a large number of "preemptive" alarms during a shift, operators are often in need of ways to prioritize the alarms received at their workstations. Thus, there is a need for graphical interface software that enables operators to prioritize alarms and make choices in responding to alarms when the number of alarms being received at the operator's workstation is excessive and there are too many to be handled at once.

[0007] Another problem associated with currently available user interfaces for process control systems is the lack of contextual information about a specific alarm when the alarm is presented at the user interface or monitor. Specifically, typical

systems include an alarm banner disposed at the bottom of the screen whereby all of the information about the physical plant component and the alarm, including the date and time are presented on a single line. As a result, limited information is provided to the operator at a first glance. The operator must then manipulate the screen to receive additional information and make a judgment as to what appropriate action is needed and at what time (i.e., now or later). It would be helpful to provide an operator with improved information about a specific alarm that includes which other active alarms are present in the same control module, equipment module or operator unit. In short, there is a need for improved alarm contextual information which provides operators with additional information regarding other active alarms thereby enabling operators to better understand individual alarms in context of other active alarms.

**[0008]** Another problem associated with alarm signals of process control systems is, simply put, organization. Specifically, due to the large number of field devices sending alarm signals, an operator can be overwhelmed with the sheer number of alarm signals. This situation is commonly referred to as a "alarm flood." The cause of an alarm flood may be a chain reaction of problems occurring within a system. To better evaluate and take corrective action when an alarm flood is occurring, there is a need for improved organization of multiple alarms wherein the alarms are organized hierarchically with age profiles so that an operator can more easily determine the cause of the alarm flood in the "leading edge" of the alarm flood.

**[0009]** Another problem confronted with operators of complex systems involves the number of alarms received and the ability to anticipate problems before they occur. Specifically, there is a need for operators to provide themselves with "display alerts" that would provide operators with specific information used to augment

the alarm systems currently available. Specifically, such display alerts could be shift or session specific and could provide tactical alert information enabling an operator to anticipate problems. Such tactical display alerts could also provide one-time operational targets or help the operator ensure that the expected control system response is being achieved.

## Summary of the Disclosure

**[0010]** In satisfaction of the aforenoted needs, a color display encoding method and software is disclosed that combines an indication of alarm priority and alarm age and allows the operator to manipulate the display of other details regarding an alarm.

**[0011]** In an embodiment, a disclosed alarm "detail display" combines information about a selected alarm, with information about other alarms active in the same control module, as well as parent control objects (equipment modules, units, etc.) and plant areas, including a means to navigate displays providing more information about those control objects.

**[0012]** In an embodiment, alarm monitoring displays are disclosed that are suitable for wireless and/or handheld devices (e.g., a "Pocket PC" or a "PDA").

**[0013]** In an embodiment, dynamically configurable "display alerts" are disclosed that supplement the "permanent" alarms in the process control system to monitor "one-time" conditions or operations progress. Such display alerts include, but are not limited to: "target" alerts for control parameters to assist in maintaining a constant target value (+/- an acceptable error) for a specified period of time; "range"

alerts to ensure a control parameter stays within specified limits; "ramp" alerts to ensure a control parameter changes in a linear way to a new target value and within the expected time period; and summary displays for "display alerts" for defining and identifying which alerts are running, and the current status of said alerts.

**[0014]** In an embodiment, hierarchical "alarm profile" displays are disclosed which are intended to point out where and when the heaviest alarm activity is taking place. Such alarm profile displays can provide a warning or indication of when operators face "alarm floods." In a refinement, the alarm profile displays can indicate active alarm counts vs. alarm age. In another refinement, the alarm profiles can include a selectable time span for: (a) all or selected alarms, (b) all or selected plant areas, (c) all or selected equipment units, and/or equipment modules. In another refinement, the alarm profile displays can include alarm summaries by alarm age, thereby making it easy to identify the still active alarms that occurred on the "leading edge" of the "alarm flood "

**[0015]** In an embodiment, various means for automatically superimposing alarm profiles in the form of a temporary display layer on process graphic displays are disclosed which includes means for finding graphical elements associated with control units, equipment modules, etc. so that alarm profiles can be seen in the spatial context of plant equipment schematics and in process graphical display formats that are familiar to operators.

## Brief Description of the Drawings

**[0016]** The disclosed embodiments and methods are described more or less diagrammatically in the following drawings, wherein:

**[0017]** Fig. 1 is a disclosed display for a single monitor workstation environment showing an alarm banner with an expanded alarm display for a primary inlet control valve that is obtained by clicking the "i" button next to the FIC-101 banner in the lower left-hand corner of the display of Fig. 1;

**[0018]** Fig. 2 is a primary control display for the valve FIC-101 that is obtained by pressing the FIC-101 button disposed in the lower left-hand corner of the display illustrated in Figs. 1 or 2;

**[0019]** Fig. 3 is an expanded view of the floating panel in the upper left portion of the display of Fig. 2 which is expanded by clicking on the set point value (680) shown in the floating display of Fig. 2 and which enables the operator to enter a new set point value in the space provided;

**[0020]** Fig. 4 is an illustration of a disclosed three monitor workstation environment with various floating displays designed in accordance with this disclosure;

**[0021]** Fig. 5 is another view of a three monitor workstation environment illustrating various examples of watch panels on the left and right and specific alarm information in the central panel;

**[0022]** Fig. 6 is an illustration of a display for a hand-held PC, pocket PC or personal digital assistant ("PDA") device;

**[0023]** Fig. 7 is an illustration of a display for a PDA device with various alarms indicated thereon;

**[0024]** Fig. 8 is another illustration of a graphic display for a PDA device displaying specific alarm information for the inlet flow control valve illustrated in Figs. 2 and 3;

**[0025]** Fig. 9 illustrates a graphics display for a single monitor workstation environment showing an alarm related to the primary inlet flow valve identified as FIC-101 but where the object upstream pump identified as VSPMP-101 has been clicked on to provide further information as the alarm cause is being investigated;

**[0026]** Fig. 10 illustrates the graphic display as a result of the actions taken by the operator in connection with Fig. 9 wherein details relating to the pump VSPMP-101 are provided;

**[0027]** Fig. 11 is an illustration of a graphic display whereby an operator has established a "target" alert of 720° for a reactor tank TI-101 with an acceptable deviation of +/- 5° for a duration of one hour.

**[0028]** Fig. 12 is a graphic display of a "range" alert whereby the operator knows a particular stream flow should fall within the range of 110 to 115 gpm and has set an alert to go off in the event the flow falls outside of that range;

**[0029]** Fig. 13 is a graphic display of a "ramp" alert to check for a steady ramped or increased volume measurement within a holding tank over a period of 12 hours so that the level within the tank rises to 360 inches;

**[0030]** Fig. 14 is another graphic display summarizing the target, range and ramp alerts described above in Figs. 11-13;

**[0031]** Fig. 15 is an enlarged view of the summary of the target, range and ramp alerts illustrated in Fig. 14;

**[0032]** Fig. 16 is an expanded view of a summary of the ramp alert illustrated in Fig. 13 at a subsequent time to that illustrated in Fig. 15;

[0033] Fig. 17 is an expanded view of the ramp alert illustrated in Fig. 13 at a subsequent time to those illustrated in Figs. 15 and 16 as the goal of 360 inches is at or near completion;

[0034] Fig. 18 is a graphic display for an alarm profile summary that indicates active alarm counts, stacked by priority and charted over a previous time period;

[0035] Fig. 19 is an illustration of a graphic display for an alarm profile for a specific area "A" which includes two reactors and a separator as shown;

[0036] Fig. 20 is a graphic display where an advance display button features has been clicked on and alarm summaries are presented on top of a schematic illustration of the process control area;

[0037] Fig. 21 is an example of a trend display for a control valve that illustrates an abrupt decrease in flow within the past hour;

[0038] Fig. 22 is another graphic trend display for the same control valve illustrated in Fig. 21, but over a two hour time period as opposed to a one hour time period;

[0039] Fig. 23 is a manipulated display showing the same data of Fig. 21 to identify a minimum flow value and when the minimum flow value occurred;

[0040] Fig. 24 illustrates the flow drop over a period of four minutes and 45 seconds for the control valve illustrated in Figs. 21-23;

[0041] Fig. 25 is another graphical presentation of the drop in flow rate illustrated in Figs. 21-24;

[0042] Fig. 26 is a comparison of the drop in flow rate for the valve illustrated in Figs. 21-25 with the flow rates of two other valves over the same time period; and

[0043] Fig. 27 is a further manipulation of the display shown in Fig. 26 used to analyze the data over a more discreet time period.

[0044] It should be understood that the figures are not to scale and that various graphical displays are illustrated in partial, diagrammatic and fragmentary views. In some figures, details may have been omitted which are not necessary for an understanding of this disclosure or which render other details difficult to perceived. It should be understood, of course, that this disclosure is not limited to the particular embodiments or graphical displays illustrated herein.

## Detailed Description of the Presently Preferred Embodiments

[0045] Turning to Figs. 1 and 2, a single monitor workstation graphic display is illustrated wherein the screen 10 includes an alarm panel 11, a system status panel 12, a main display area 13, a tool-panel 14 and a selector panel 15. In the screen 10 shown in Fig. 1, the alarm panel 11 indicates a moderate priority alarm for the control valve identified as FIC-101 and with an object shown at 16 in Fig. 2 which is a primary inlet to the reactor 17, also shown in Fig. 2. The alarm is indicated at 18 in Fig. 1. In an embodiment, the color of background of the alarm panel 11 may indicate when the alarm was activated. For example, a white or clear background could be used for very recent alarms while colored backgrounds could be used for alarms that have been active for an excess of one hour and a dark or black background could be used for alarms that have been active for eight or more hours. The summary shown in the alarm banner 11 for FIC-101 is created by clicking the "i" button 21 next to the indicator 22 in Figs. 1 and 2. For additional information, the operator can click the "i+" button 23 in Fig. 1 to produce the floating display 24.

**[0046]** The display logic for the button 23 captures the module name "FIC-101" for the alarm currently selected in the alarm banner 11 and constructs a calling informational string of "Display='DvAlarmInfo'; Module='FIC-101'" and then passes it on to the workspace function "OPEN_DISPLAY." The DvAlarmInfo display was configured with a panel category of ALARMINFO. In the framework utilized herein, there is a single floating panel configured to be an ALARMINFO category target so that the floating panel is chosen for the DvAlarmInfo display. If another display is currently open, it is closed to open the display 24 as shown in Fig. 1 when the button 23 is pressed.

**[0047]** The display logic in a "DvAlarmInfo" display such as that shown at 24 in Fig. 1 requires a module name for it's launch information. Finding "FIC-101", it uses that name in calls to the data services layers to obtain information about the valve 16 labeled FIC-101 (see Fig. 2) and it's containing unit and equipment modules. With an understanding of the alarm situation in valve FIC-101, and its related modules, the operator closes the "DvAlarmInfo" floating panel 24, and looks at the primary control display for FIC-101 as shown in Fig. 2, by pressing the button 22 in the alarm banner 11.

**[0048]** Still referring to Fig. 2, by way of example only, the display logic for the alarm banner 11 buttons captures the module name ("FIC-101") and constructs a calling info string of "Panel='MAIN'; Module='FIC-101'; Select="FIC-101"; KeepARScrollOneDim", and then passes the string to workspace function "OPEN_PCD". The OPEN_PCD function resolves the primary control display name "REACTOR1_TOP" for module "FIC-101". It then asks the workspace to resolve PANEL='MAIN', and to replace the display currently in that panel with REACTOR1_TOP. REACTOR1_TOP originated through an import of a P&ID drawing

from another system, so it's native aspect ratio is much wider than the MAIN panel 13 in the current framework. A "KeepARScrollOneDim" directive says that the aspect ratio for REACTOR1_TOP should be maintained while scaling it to fill the MAIN panel 13, with scroll bars for portions of the display that wont fit.

**[0049]** The Select="FIC-101" directive is forwarded to "REACTOR1_TOP" telling it to resolve the "best" selectable graphic object associated with "FIC-101" and automatically give it selection focus (scrolling the display as necessary so the selected object is visible and as centered in the MAIN panel as possible.) The presence of the "KeepARScrollOneDim" and "Select" directives overrides the default workspace behavior which remembers the scaling and scroll position last used on a display, for when it is opened again in the same user/session.

**[0050]** After looking at "near by" alarm conditions and process measurements, the operator chooses to make an adjustment to the setpoint on FIC-101, and watch how that control loop reacts. The faceplate display 25 shown in Fig. 2 is the ideal interface for what the operator has in mind, so he pushes the FIC-101 button 22 which is still in the alarm banner 11. The display logic for the faceplate button 22 captures the module name ("FIC-101") associated module, constructs a calling info string of "Module='FIC-101'", then passes it to workspace function "OPEN_FPD".

**[0051]** The OPEN_FPD function resolves the faceplate display name "PID_LOOP_FP" for module "FIC-101". The "PID_LOOP_FP" display 25 was configured with a panel category of "FP". In the current framework, there are two floating panels configured to be an "FP" targets, both are currently empty, so floating panel 25 on the left is chosen as it was placed ahead of the other floating panel in the

floating panel "use order" configuration. An instance of the PID_LOOP_FP display 25 is opened there, passing it the launch information: "Module='FIC-101'".

**[0052]** The display logic in the "PID_LOOP_FP" display 25 expects a module name to be in it's launch information. Finding "FIC-101", it uses that name in calls to the data services layers identify the parameters in FIC-101 it will be reading. Several parameter/field values from the valve FIC-101(see 16 in Fig. 2) are used repeatedly in the FIC-101 display 25, most notably the scaling parameter associated with the pressure value "PV" and system pressure "SP" parameters. The "pre-update" logic for "PID_LOOP_FP" read the EU0 and EU100 values, engineering units string and decimal places information and stores them in "local display variables" which can be referenced by any of the graphic elements in "PID_LOOP_FP". In short order, a new instance of "PID_LOOP_FP" appears in the floating panel initially located at its anchor point.

**[0053]** Turning to Fig. 3, if the operator thinks a significant system pressure change is appropriate and using the nudge up 26 or down 27 buttons won't do, the operator can push on the button 28 indicating the set point value. The display logic for the system pressure button 28 click is to ask the workspace to provide a standard numeric data dialog. The "PID_LOOP_FP" display 25a of Fig. 3 is designed to also be used in workspaces running on PDAs, so it constructs a parameter info string of "InParentDisplay; DockBottom; Title='FIC-101/PID1/SP.CV'" and passes it to the workspace function "NumericDataEntry". The NumericDataEntry workspace function sees that the workspace was launched with a "ShowKBOnScreen" preference (perhaps running on a hardware where the keyboard is not always present), so it chooses an instance of the standard numeric data dialog with an on screen keypad. The workspace

resolves the dimensions and location of this instance of the PID_LOOP_FP display, and locates the dialog box at the bottom of the faceplace display.

**[0054]** The operator can enter a new value for the setpoint in the box 29. The operator then sees the new value for setpoint reflected in the value shown on the setpoint button 28 and is assured that the controller is now using/reporting the new setpoint value. The mode shown in Fig. 3 is in AUTO so the confirms some changes in the control (valve) output, and shortly thereafter the pressure starts moving in the desired direction.

**[0055]** In Fig. 4, the operator can use a three monitor workspace with screens 10a, 10b, 10c. When a new alarm appears in the alarm banners 11b or 11c, the operator can recognizes the "tag" appearing in the banner and can confirms the module description. To correct a problem upstream of FIC-101(see Fig. 2), the operator can push the left faceplate button 31 in Fig. 2 to view upstream components. With a three monitor display of Figs. 4 and 5, the operator can put a copy of the upstream display in one of the empty panes 32-35 in the left monitor screen 10a. To accomplish this, the operator pushes the "copy panel content" button 36 in the toolbar 14b over the main panel 10b. The display logic behind the copy panel content button 36 prepares a parameter information string of "Panel=MAIN" and calls the workspace function CopyPanelContent. The Copy PanelContent function captures the display name currently in the specified panel, the launch information used to create that display, and the current scaling, and scroll position settings.

**[0056]** The operator then pushes a "paste" button, e.g., 37, in the combined information and tool button bar 38 of an empty panel, for example the panel 33, of the left monitor or screen 10a. The paste button 37 essentially prepares a parameter

information string of "Panel='<my panel id>'; UseSourceScale", and calls the workspace function that "paste copied panel contents" to "this" panel (in this case 33). The new instance of the display, with the original launch information is opened in the panel 33. The scaling of the source display is preserved, but since the panel is half the size of the source panel, the view is centered on the center point of the source view, and horizontal and vertical scroll bars appear.

**[0057]** Turning to Fig. 6, an operator or operations supervisor monitor the system using a PDA 40. As shown in Fig. 7, the operator can keep the "TOP_ALARMS" display open in the main panel 41. The TOP_ALARMS display can be closed by pressing the "Top" button 42 in the toolbar panel 43 as shown in Fig. 7.

**[0058]** In Fig. 8, the PDA 40 produces an alarm banner 44 and, optionally, a warning-level alarm sound. The operator can push the "i+" button 45 to check for other alarms in this module, equipment module, and unit. The display logic for the "i+" button 45 of a PDA 40 is designed to call up the ALARMINFO display for the selected module. Normally the ALARMINFO display would be retrieved from the DEFAULT subtree under the display configuration storage root directory. However, this workspace was started with the launch information "DisplayPref=PDA", so it will attempt to find a display definition named ALARMINFO in subtree named PDA, before looking for it in the DEFAULT subtree.

**[0059]** Returning a single workstation as shown in Fig. 9, as one example, the operator has been noticing intermittent deviation alarms on the primary inlet flow control loop for reactor 1 (RXTR 1). Observing the primary control display for reactor 1, an operator could conclude that the deviation alarm occurs when demand peaks for a few minutes as a result of new production rates. To retrieve information on the inlet

flow feed pump VSPMP-101, the operator clicks on the graphic object 51 representing the pump VSPMP-101 to generate the display of Fig. 10. The pump object 51 in the display of Fig. 9 may be taken from a standard library of graphic objects and can be configured to be a selection target, and when selected, to indicate selection with a dashed box around the pump VSPMP-101 as shown in Fig. 9 and the pump's tag string, and also to make the button visible that opens the runtime object browser application. Clicking on the pump VSPMP-101 or object 51 around the pump VSPMP-101 gives feedback that it is selected in the form of Fig. 10, and the object browser button appears.

**[0060]** In Fig. 10 the operator can review various information about the pump VSPMP-101. The first section 53 has information about the specific pump including location, ID tag number, and physical specifications. A button 54 is available here to open the "Operations Journal" application for the pump VSPMP-101. Another button 55 is provided to access the Asset Management Solutions (AMS) software data for the device VSPMP-101. The second section 56 contains information about the type and class of pump including buttons 57-60 to access the manufacturer's operating guidelines documentation, drawings, or identification pictures, and training documents such as standard procedures such as operating and maintenance procedures. The third section 61 provides location information and the fourth section 62 allows the operator change the display 10 to other upstream or downstream objects.

**[0061]** Figs. 11-17 illustrate the use of target alert, range alert and ramp alert alarm profiles. For example, if the operator had just finished responding to an alarm by making a setpoint change and was satisfied the change was accepted by the controller, the operator may want to monitor the primary control display for this change but is unable to because of other alarms. The use of a display alert may be helpful in

alleviating this problem. Turning to Fig. 11, if a temperature setpoint change is going to take an hour to raise the temperature on the product in reactor 1 (see Fig. 9) to the new target of 720°F, the operator can start a target alert by clicking on an "Add Display Alert" button 71 in the toolbar panel 14 over the main panel 10 showing the control display for reactor 1 causing the display alert dialog box 72 to appear as shown in Fig. 11.

**[0062]** If the operator desires "target alert" he or she selects tab 73. The parameter that needs to be set for the alert on is already inserted into the box 74 due to the process change. The operator sets an initial delay of 1 hour by appropriately filling in the box 75, before checking that the target value of 720° has been reached. A different target value may be entered in the box 74 if necessary and an acceptable deviation band (+/- 5 degrees) is entered into the box 76. The alert check duration of 1 hour (making sure the temperature doesn't drop or overshoot for at least an hour after the target is achieved) is entered into the box 77. If the operator doesn't have anything more to do when this alert is removed, the "acknowledge" box may be cleared. The remaining boxes in the display 72 are self explanatory and will not be described in detail here. When finished with the target alert, the operator hits the "add display alert" button 79. The display 72 closes and a runtime workspace adds the new display alert. In an hour, the controller will start checking that the value for TI/101-2/AI1/IN.CV is 720 (+/- 5) degrees, and continue for the next hour. After that point, the target alert shown in Fig. 11 will automatically remove itself.

**[0063]** Turning to Fig. 12, a range alert may be desired to check in change in output or throughput. After clicking on the button 71, the dialog 72 appears, but operator can switch to the range alert tab 81 as shown in Fig. 12. If a flow rate of 112

gpm is desired, the operator can set upper and low range limits in the boxes 82, 83 for the display alert. If a flow rate of 112.2 gpm has already been established so there is no need for an initial delay on the display alert and the boxes 84-86 are left blank. Also, if the product is to be made for an extended period of time exceeding a shift change, the boxes 87-89 can be left blank as well and clicking on the button 79 can institute the range alert.

**[0064]** A ramp alert is illustrated in Fig. 13. If a large tank needs to be filled, the operator can pull up the tank farm process display, and uses the object browser application to get the link to the product movement procedure checklist. After manually opening and closing the appropriate block valves, the operator can start the pump and verify a steady flow measurement as the product is transferred to the tank. In Fig. 13, a ramp alert is set for a plan to achieve a level of 360 inches (see box 95) in the destination tank that level will be achieved in 12 hours (see box 96) based upon a target flow rate.

**[0065]** With no discharges planned, operator expects a steady increase of the level of the tank from its present measurement, to the target over the next 12 hours. Rather than set a target alert (with no checking going on for 12 hours), a ramp alert can be chosen instead by clicking on the tab 91 to check for a steady "ramped" measurement throughout the next 12 hours. Since the next shift operator will need to shut off the transfer pump and close valves, the current operator checks the "acknowledge before removing" box 92 so the completed alert will get the next operator's attention. The operator also adds a comment in box 93 to remind the next operator what needs to be done.

**[0066]** To check the display alerts described in Figs. 11-13, the operator presses a "display alerts status" button 102 in the tool bar 14 (or alarm banner panel 11 or elsewhere). This button 102 replaces the content of the main panel 10 with the display alerts status application shown in Figs. 14 and 15, where the three display alerts of Figs. 11-13 are summarized. Comparing Figs. 14 and 15, the target flow rate of 110-115 gpm of Fig. 12 is not being achieved at the point in time represented in Fig. 15 thereby producing a warning indicator 103 while the target rate was being met in Fig. 14. Also, the target temperature of 720° set in Fig. 11 was not met in Fig. 14 but met in Fig. 15.

**[0067]** As shown in Figs. 14 and 16, during a subsequent shift, the new operator may push the display alerts status button 102 (Fig. 14) to review what the previous shift had left him. Fig. 14, would show a single display alert left over, so the operator presses the show details button 104 to get the information shown in Fig. 16 indicating a level of 315 inches in the tank, still short of the desired 360 inches.

**[0068]** After a couple of hours, the operator would notice a display alert indicator in the alarm banner 11 area had turned white and began flashing. After opening the display alert status display, the display of Fig. 17 would appear to indicate that the ramp alert of Fig. 3 has been completed, and requires acknowledgment. The operator would then acknowledge the completed display alert and press the button for the primary control display for LI-TF1-PRD23 so that the transfer pump can be stopped and the transfer valves reset.

**[0069]** Figs. 18-20 illustrate disclosed techniques for responding to alarm floods. As will be apparent to those skilled in the art, new alarms can be produced faster than the operator can keep up with. The operator can push a button 110 in the toolbar

panel 14 for the "alarm profiles" application which would appear in the main panel 13 replacing the previous display as shown in Fig. 18. The alarm profile charts indicate active alarm counts, stacked by priority, and charted over the previous hour. The top chart 111 shows the active alarm profile for all active areas under the operator's control (or alarm management scope), and automatically shows charts for each of the five most active plant areas, four of which are shown at 112-115. From Fig. 18, it is clear that area "A" (chart 112) is problematic, so the operator may press the "expand" button 116 for that area to produce the more detailed charts of Fig. 19.

**[0070]** In Fig. 19, the chart 112 of Fig. 18 becomes the upper chart in Fig. 19, with the charts for the five most active units/equipment modules in the plant area disposed below the chart 112, three of which are shown at 117-119. Fig. 19 shows that nearly all the new alarms are coming from the reactor 1 unit in chart 117. By pushing the "list alarms" button 121 for reactor 1, a list of all active alarms associated with that unit that occurred within profile time window (the previous hour) appears in the right side of the display in Fig. 19. Using the "i+" buttons 122, the DvAlarmInfo display for the alarms can be opened for full details. To get a another view on the alarm profile for reactor 1, the operator can press the "primary control display" button 123 for reactor 1 to produce the display of Fig. 20.

**[0071]** The "advanced display features" button 124 on the toolbar panel 14 enables to operator to select "add alarm profiles." This causes the runtime workspace to find the graphic elements associated with unit and equipment modules, their location on the screen, and creates a temporary display layer for the existing display which shows active alarm profiles for each major equipment grouping. The other layers in the display

are subdued or semi-transparent to make the alarm profiles easier to see as shown in Fig. 20.

**[0072]** Fig. 21 is a trend pop-up for a valve showing a distinct drop in flow rate about 1 hour ago. To check the value for a longer time period he clicks on the period button 130 in the control bar 131, and it cycles to a 2 two hour view as shown in Fig. 22. Using the keyboard arrow keys or a mouse to place the cursor back a couple of samples until the "minimum value" icon 132 appears in the legend bar 133, the operator can find and display the low point of the curve as shown in Fig. 23. As shown in Fig. 24, the slope of the downward curve can be calculated by placing another vertical bar 134 in the appropriate place as shown before the low point vertical bar 135. The flow through one valve FIC-102 may be compared and contrasted with the flow through related valves FIC-108 and FIC-112 as shown in Figs. 25-27.

**[0073]** It will be noted that the placement of various buttons, displays, toolbars, alarm banners, system status banners, etc., are relatively arbitrary and their placement may be modified substantially without departing from the spirit and scope of this disclosure. All of the graphic layouts disclosed in Figs. 1-27 are exemplary and for purposes of illustration and are clearly not intended to limit the spirit and scope of this disclosure or the appended claims.

**[0074]** As a result of the displays shown in Figs. 1-27, the operator is provided with a clear graphical interface that combines an indication of alarm priority and alarm age and allows the operator to manipulate the display of other details regarding a specific alarm or alarms. Information regarding a selected alarm may be combined with information from other alarms and equipment data. Further, the graphical displays are applicable to PDA devices for use by supervisors as well as

operators. Various types of display alerts and hierarchical alarm profiles are also provided to improve the effectiveness of plant operators.

What is Claimed is:

1. A graphical user interface for a process control system that includes a plurality of data inputs and a variety of alarms for said data inputs, the interface comprising:

simultaneous display of multiple alarms wherein the each of alarm displays provide indicia of alarm priority and alarm age.

2. The interface of claim 1 wherein each of the alarm displays comprises contextual information about the alarm, the interface further comprising simultaneous display of indicia of all other active alarms in at least one of a common control module, a common equipment module or a common process unit.

3. The interface of claim 1 further comprising a listing of all active alarms along with alarm age profiles for each active alarm.

4. The interface of claim 3 wherein the listing of all active alarms is divided into at least one of common control modules, common equipment modules or common process units.

5. The interface of claim 4 wherein the listing of all active alarms comprises a total active alarm listing and at least three sub-categories of alarms divided by one of common control modules, common equipment modules or common process units.

6. The interface of claim 1 further comprising a plurality of different operator definable display alerts for augmenting the simultaneous display of multiple alarms.

7. The interface of claim 6 wherein one type of display alert that comprises setting a target display alert for a target range for a process variable wherein the target display alert may begin immediately or after a delay and continue indefinitely or for a limited time and the target display alert provides an alarm when the target range is achieved or when the target range is not achieved within a preselected time period.

8. The interface of claim 6 wherein one type of display alert that comprises setting a range display alert for a desired value range for a process variable wherein the range display alert may begin immediately or after a delay and continue indefinitely or for a limited time and the range display alert provides an alarm when the process variable falls outside of the desired value range.

9. The interface of claim 6 wherein one type of display alert comprises setting a ramp display alert for a desired accumulated value for an output process variable wherein the ramp display alert provides an alarm when the actual accumulated value for the output process variable approaches and exceeds the desired accumulated value.

10. The interface of claim 1 wherein the alarms are color coded to provide an indication of alarm priority and alarm age.

11. The interface of claim 1 further comprising a details display for each alarm comprising information about the alarm and information about other alarms active in the same control module.

12. The interface of claim 11 further comprising parent control objects and means to navigate displays providing more information about the parent control objects.

13. The interface of claim 1 wherein the interface is adaptable for PDA or handheld devices.

14. The interface of claim 6 further comprising summary displays for a plurality of the display alerts and the current status of all display alerts.

15. The interface of claim 1 further comprising hierarchical alarm profile displays indicating where and when a heaviest alarm activity is occurring.

16. The interface of claim 1 comprising graphical displays of active alarm counts vs. alarm age profiles.

17. The interface of claim 16 wherein the alarm profiles may be defined by at least one of time span, plant area, process unit and equipment modules.

18. A graphical user interface for a process control system that includes a plurality of data inputs and a variety of alarms for said data inputs, the interface comprising:

simultaneous display of multiple alarms wherein the each of alarm displays provide indicia of alarm priority and alarm age,

a plurality of alarm profiles wherein alarms are grouped by at least one of time span, plant area, process unit and equipment module,

the alarm profiles being super imposable on a process graphic display so that alarm profiles can be seen in the spatial context of equipment schematics depicted in the process graphic display.

19. A machine readable medium having instructions stored thereon that, when executed, causes a machine with at least one monitor to:

generate a graphical user interface for a process control system that includes a plurality of data inputs and a variety of alarms for said data inputs, the interface including

simultaneous display of multiple alarms wherein the each of alarm displays provide indicia of alarm priority and alarm age,

each of the alarm displays comprising contextual information about the alarm, the interface further comprising simultaneous display of indicia of all other active alarms of at least one of a common control module, a common equipment module or a common process unit,

a plurality of alarm profiles wherein alarms are grouped by at least one of time span, plant area, process unit and equipment module,

the alarm profiles being super imposable on a process graphic display so that alarm profiles can be seen in the spatial context of equipment schematics depicted in the process graphic display.

20. The machine readable medium of claim 19 further having instructions stored thereon that, when executed, causes the machine to display a plurality of different operator definable display alerts for augmenting the simultaneous display of multiple alarms.

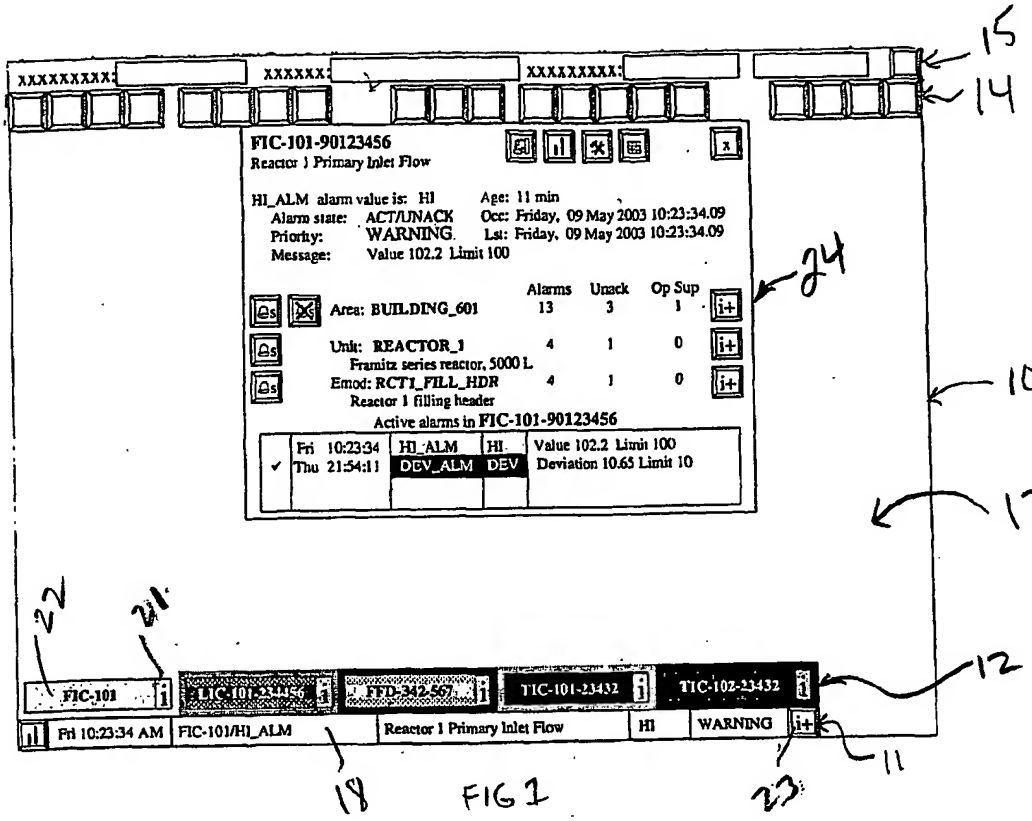

FIC-101-90123456
Reactor 1 Primary Inlet Flow
HI_ALM alarm value is: HI
Alarm state: ACT/UNACK
Priority: WARNING
Message: Value 102.2 Limit 100
Age: 11 min
Occ: Friday, 09 May 2003 10:23:34.09
Lst: Friday, 09 May 2003 10:23:34.09
Alarms Unack Op Sup
Area: BUILDING_601 13 3 1
Unit: REACTOR_1 4 1 0
Framitz series reactor, 5000 L
Emod: RCT1_FILL_HDR 4 1 0
Reactor 1 filling header
Active alarms in FIC-101-90123456
Fri 10:23:34 HI_ALM HI Value 102.2 Limit 100
Thu 21:54:11 DEV_ALM DEV Deviation 10.65 Limit 10
FIC-101
LIC-101-23456
FFD-342-567
TIC-101-23432
TIC-102-23432
Fri 10:23:34 AM
FIC-101/HI_ALM
Reactor 1 Primary Inlet Flow
HI
WARNING
15
14
24
10
13
22
21
12
11
18
23

FIG 1

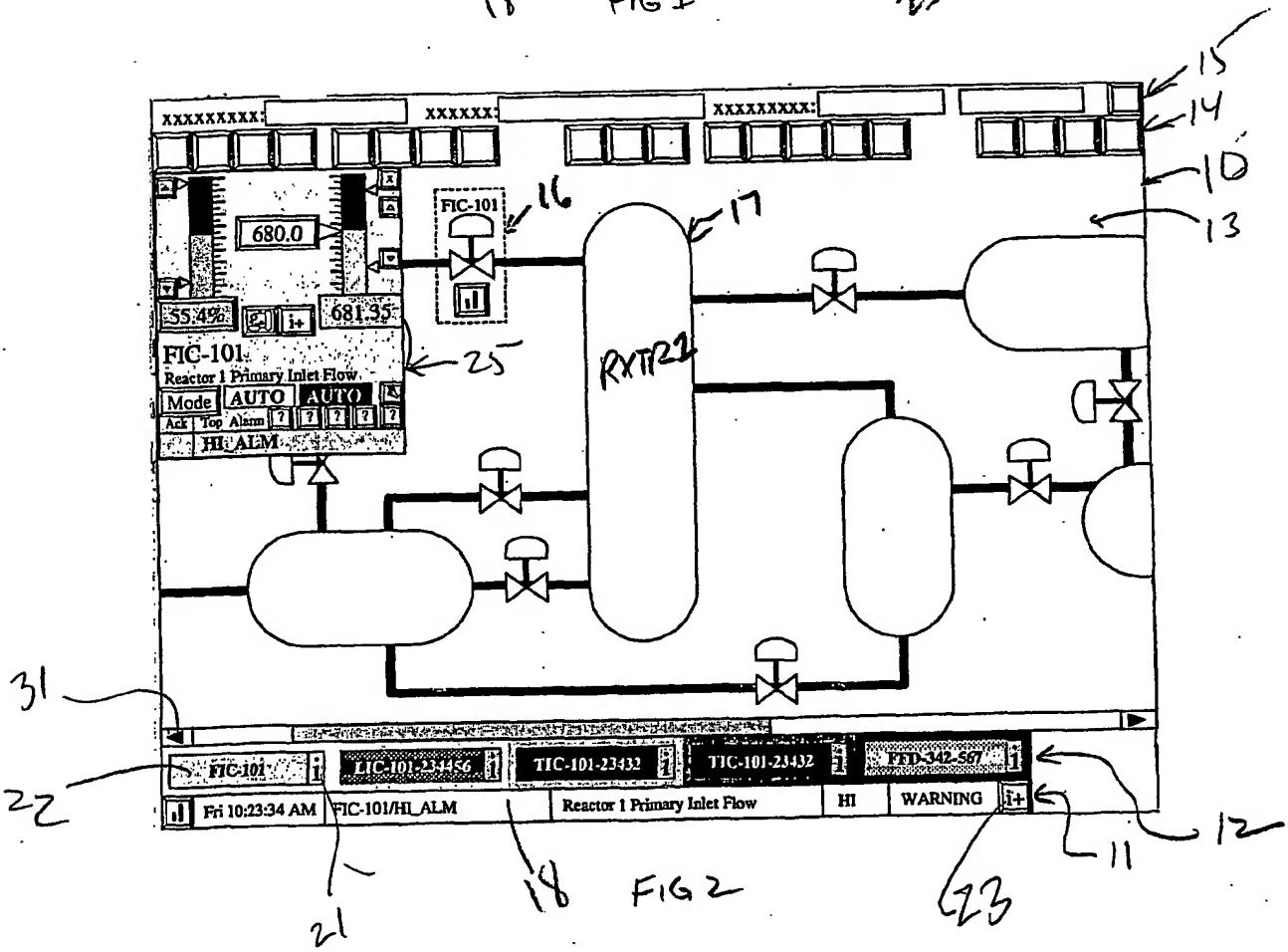

680.0
55.4%
681.35
FIC-101
Reactor 1 Primary Inlet Flow
Mode AUTO AUTO
Ack Top Alarm
HI_ALM
FIC-101
16
17
RXT22
25
15
14
10
13
31
22
21
18
23
12
11
FIC-101
LIC-101-23456
TIC-101-23432
TIC-101-23432
FFD-342-567
Fri 10:23:34 AM
FIC-101/HI_ALM
Reactor 1 Primary Inlet Flow
HI
WARNING

FIG 2

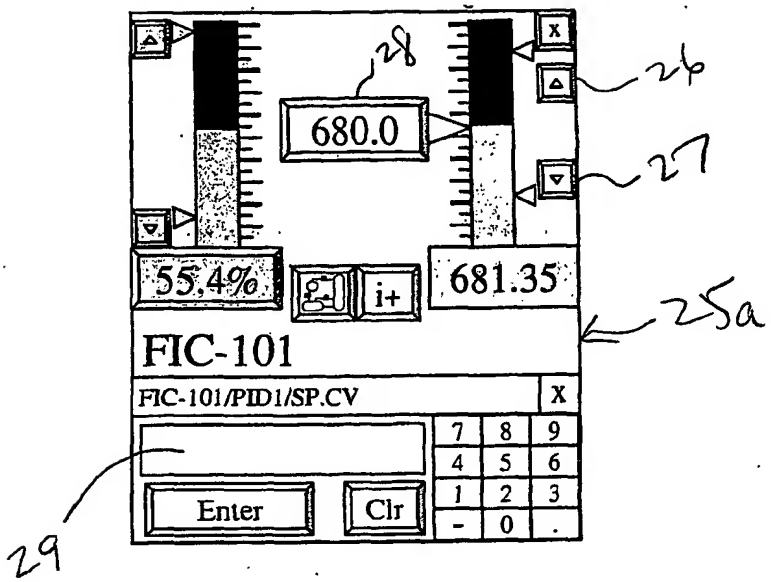

28
680.0
26
27
55.4%
i+
681.35
25a
FIC-101
FIC-101/PID1/SP.CV
X
7 8 9
4 5 6
1 2 3
- 0 .
Enter
Clr
29

FIG. 3

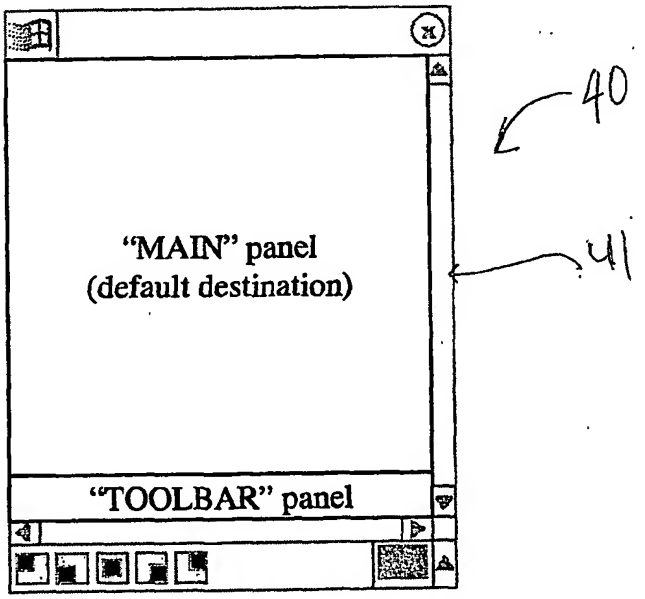

40
"MAIN" panel
(default destination)
41
"TOOLBAR" panel

FIG 6

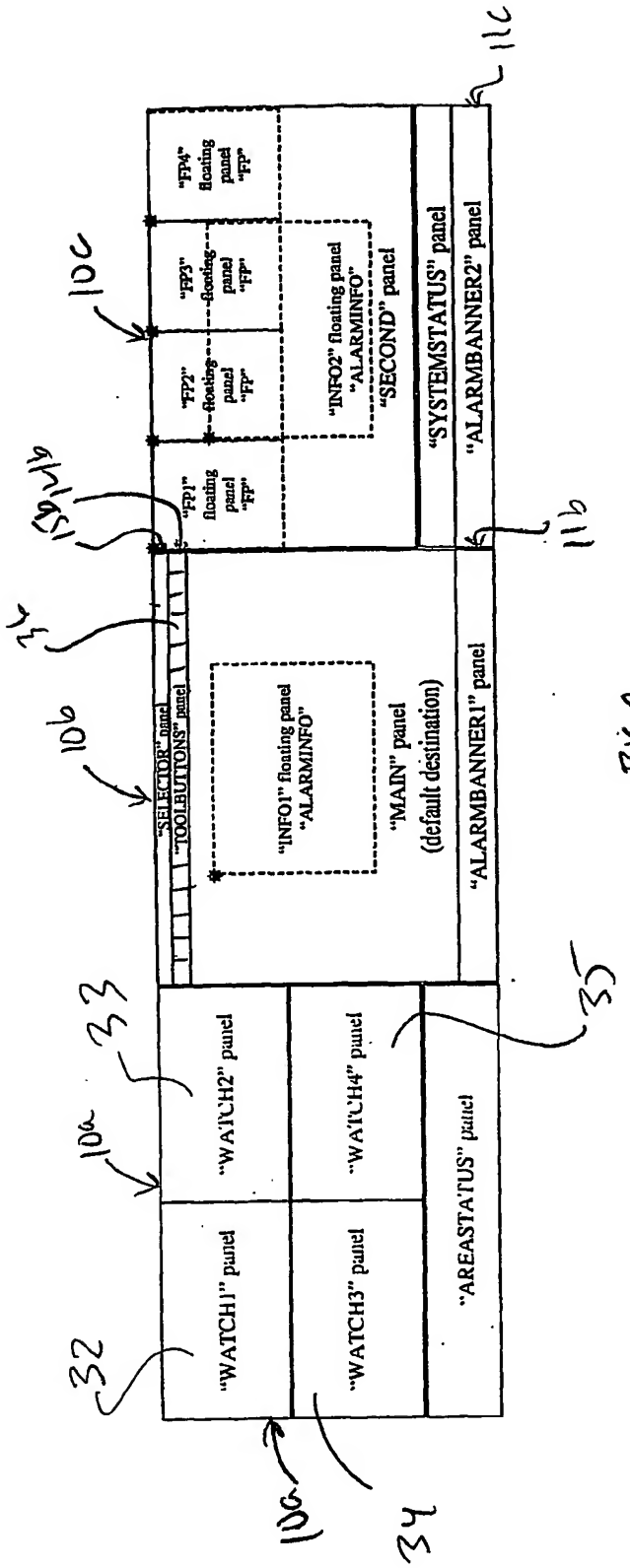

"FP4" floating panel "FP"
"FP3" floating panel "FP"
"FP2" floating panel "FP"
"FP1" floating panel "FP"
"INFO2" floating panel "ALARMINFO"
"SECOND" panel
"SYSTEMSTATUS" panel
"ALARMBANNER2" panel
"SELECTOR" panel
"TOOLBUTTONS" panel
"INFO1" floating panel "ALARMINFO"
"MAIN" panel (default destination)
"ALARMBANNER1" panel
"WATCH2" panel
"WATCH4" panel
"AREASTATUS" panel
"WATCH1" panel
"WATCH3" panel
10c
10b
10a
32
33
34
35
36
116

Fig 4

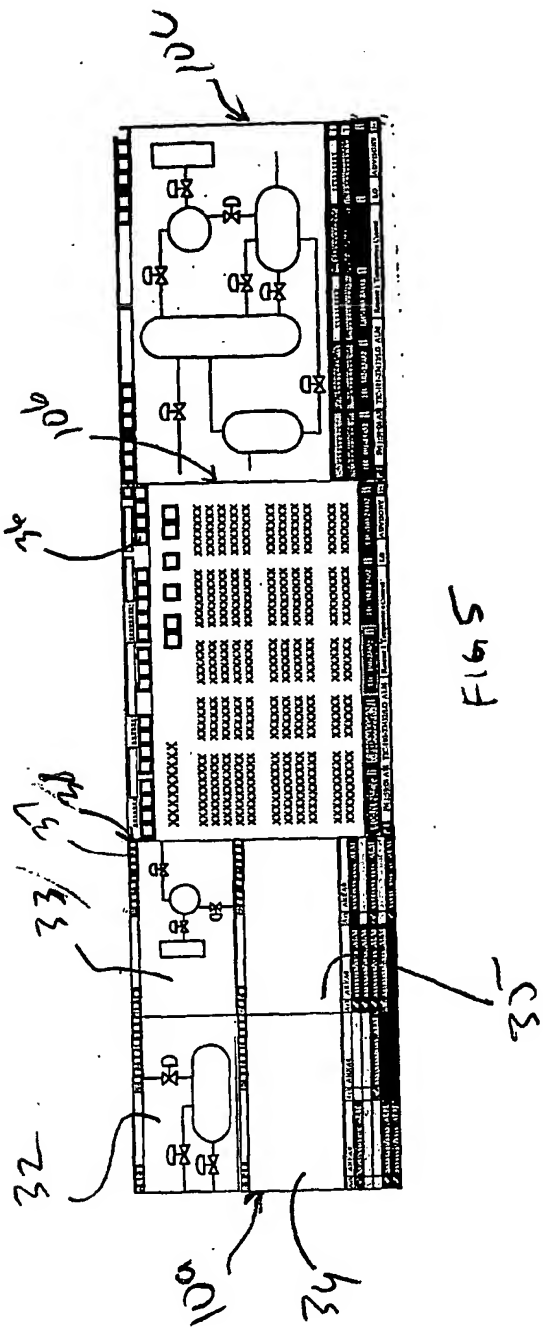

10
10b
32
33
34
35

Fig 5

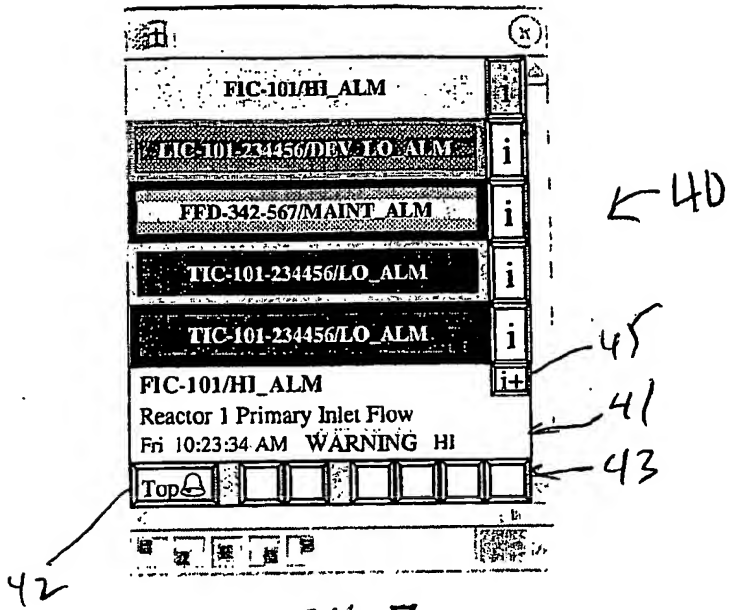

FIC-101/HI_ALM
LIC-101-234456/DEV_LO_ALM
FFD-342-567/MAINT_ALM
TIC-101-234456/LO_ALM
TIC-101-234456/LO_ALM
FIC-101/HI_ALM
Reactor 1 Primary Inlet Flow
Fri 10:23:34 AM WARNING HI
Top
40
45
41
43
42

FIG 7

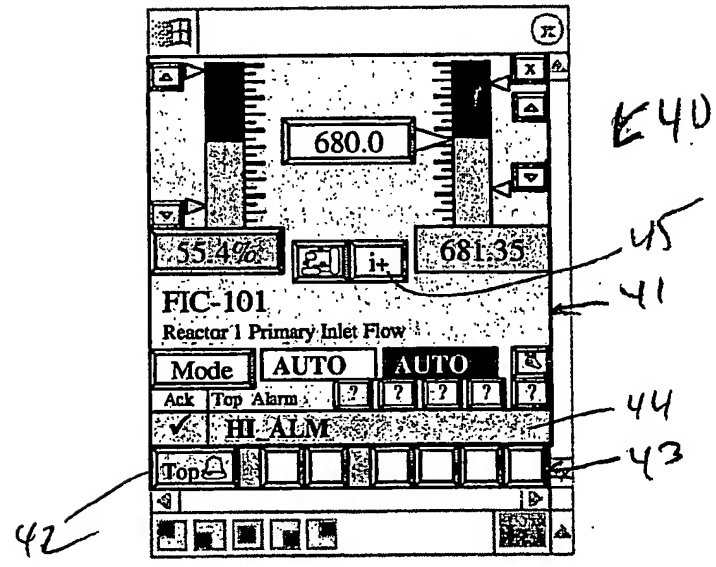

680.0
55.4%
681.35
FIC-101
Reactor 1 Primary Inlet Flow
Mode
AUTO
AUTO
Ack
Top Alarm
HI_ALM
Top
40
45
41
44
43
42

FIG 8

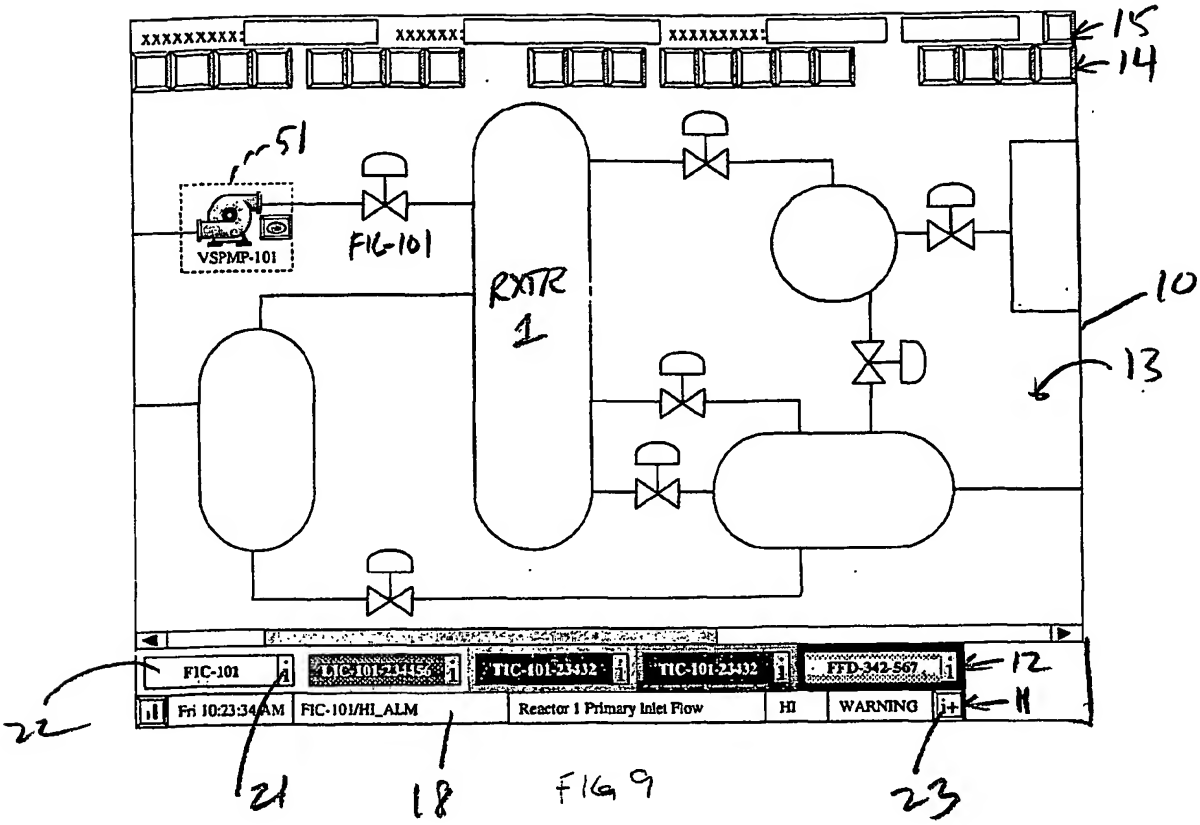

XXXXXXXXX
XXXXXX
XXXXXXXXX
15
14
51
VSPMP-101
FIC-101
RXTR 1
10
13
FIC-101
LLC-101-234456
TIC-101-23432
TIC-101-23432
FFD-342-567
12
Fri 10:23:34 AM
FIC-101/HI_ALM
Reactor 1 Primary Inlet Flow
HI
WARNING
11
22
21
18
23

FIG 9

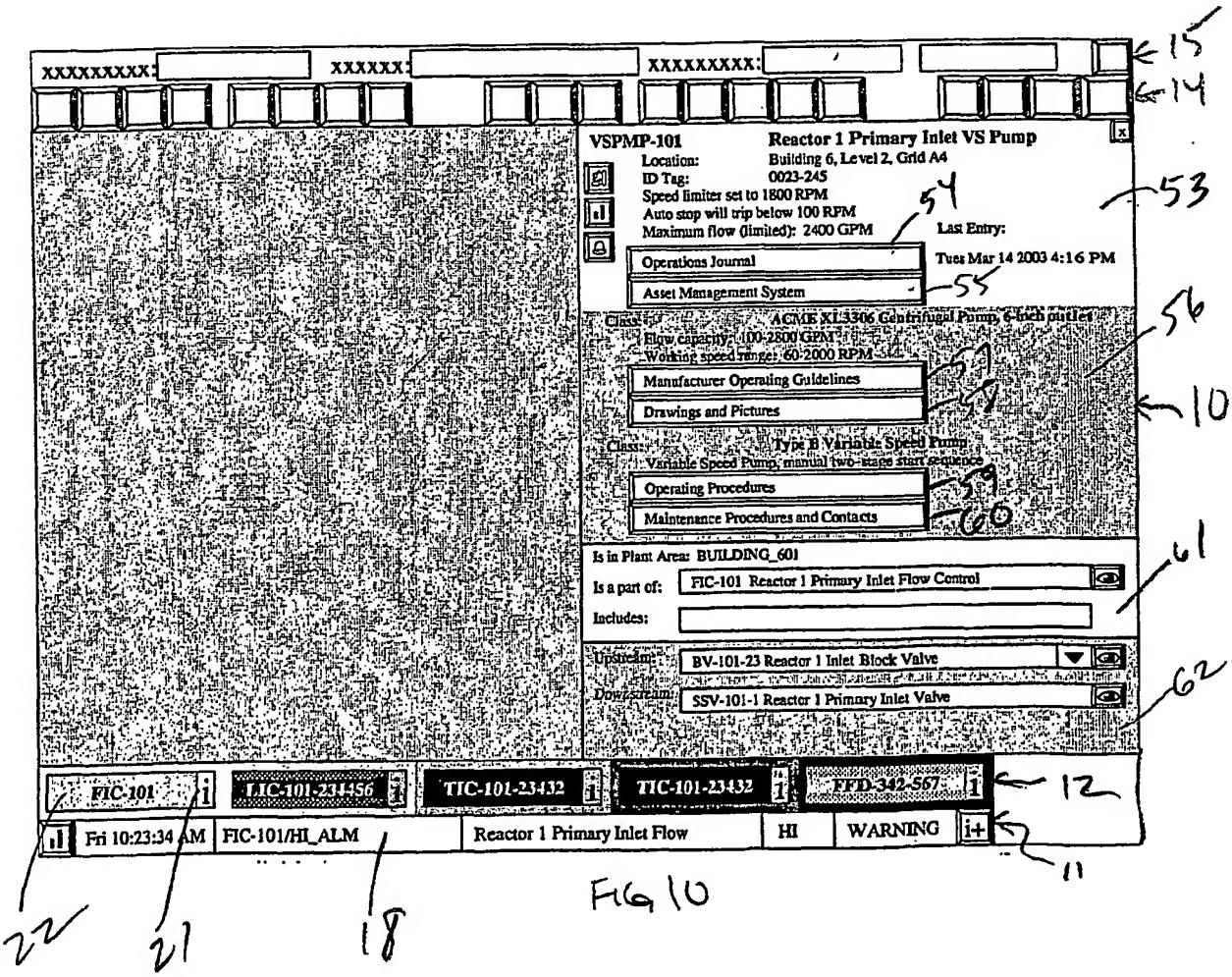

XXXXXXXXX
XXXXXX
XXXXXXXXX
15
14
VSPMP-101
Reactor 1 Primary Inlet VS Pump
Location: Building 6, Level 2, Grid A4
ID Tag: 0023-245
Speed limiter set to 1800 RPM
Auto stop will trip below 100 RPM
Maximum flow (limited): 2400 GPM
Last Entry:
54
53
Operations Journal
Tues Mar 14 2003 4:16 PM
Asset Management System
55
ACME XL3306 Centrifugal Pump, 6-inch outlet
Flow capacity: 100-2800 GPM
Working speed range: 60-2000 RPM
56
Manufacturer Operating Guidelines
57
Drawings and Pictures
10
Type B Variable Speed Pump
Variable Speed Pump, manual two-stage start sequence
58
Operating Procedures
59
Maintenance Procedures and Contacts
60
Is in Plant Area: BUILDING_601
Is a part of: FIC-101 Reactor 1 Primary Inlet Flow Control
61
Includes:
Upstream: BV-101-23 Reactor 1 Inlet Block Valve
Downstream: SSV-101-1 Reactor 1 Primary Inlet Valve
62
FIC-101
LLC-101-234456
TIC-101-23432
TIC-101-23432
FFD-342-567
12
Fri 10:23:34 AM
FIC-101/HI_ALM
Reactor 1 Primary Inlet Flow
HI
WARNING
11
22
21
18

FIG 10

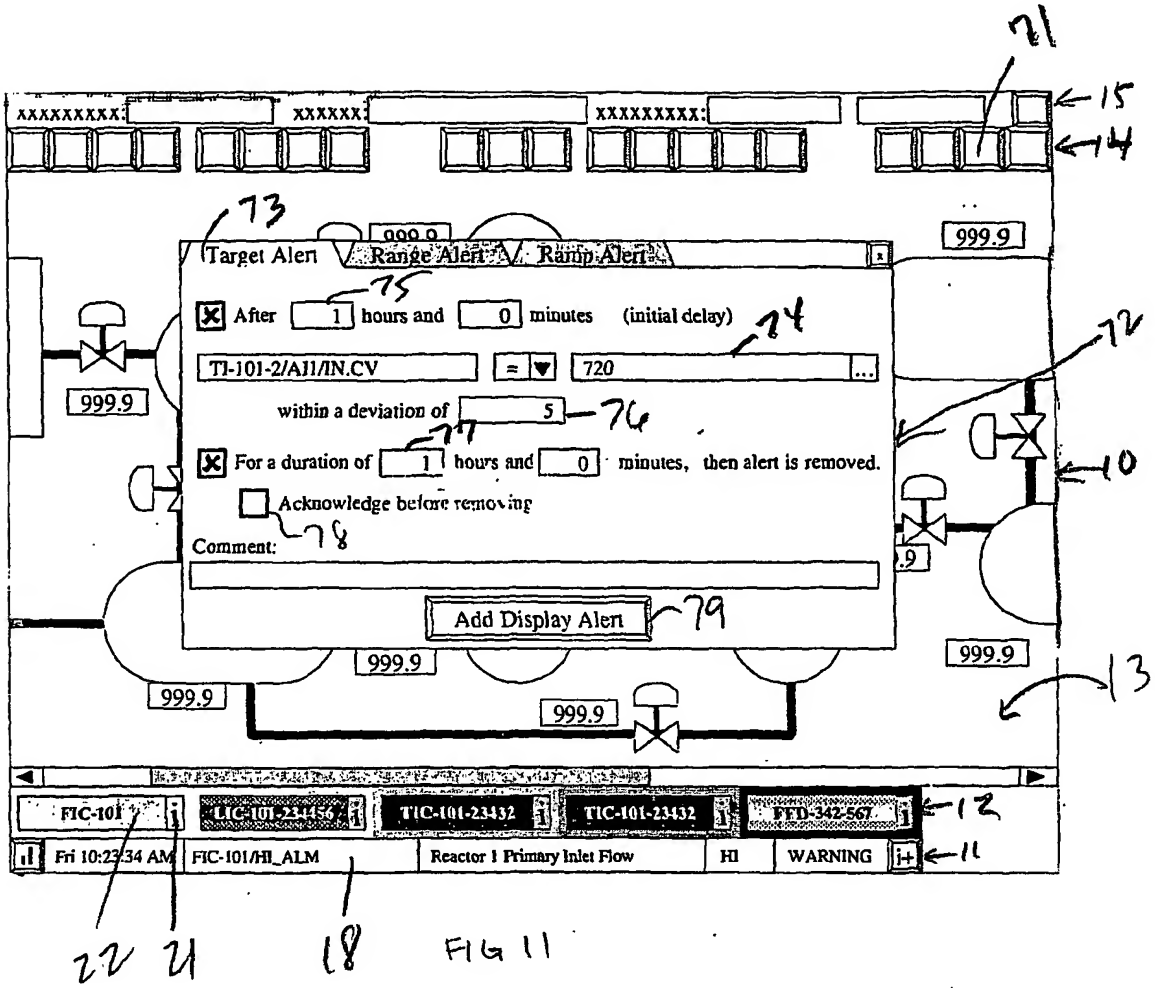

Target Alert
Range Alert
Ramp Alert
After 1 hours and 0 minutes (initial delay)
TI-101-2/AI1/IN.CV
720
within a deviation of 5
For a duration of 1 hours and 0 minutes, then alert is removed.
Acknowledge before removing
Comment:
Add Display Alert
999.9
FIC-101
LIC-101-23456
TIC-101-23432
TIC-101-23432
FED-342-567
Fri 10:23:34 AM
FIC-101/HI_ALM
Reactor 1 Primary Inlet Flow
HI
WARNING

FIG 11

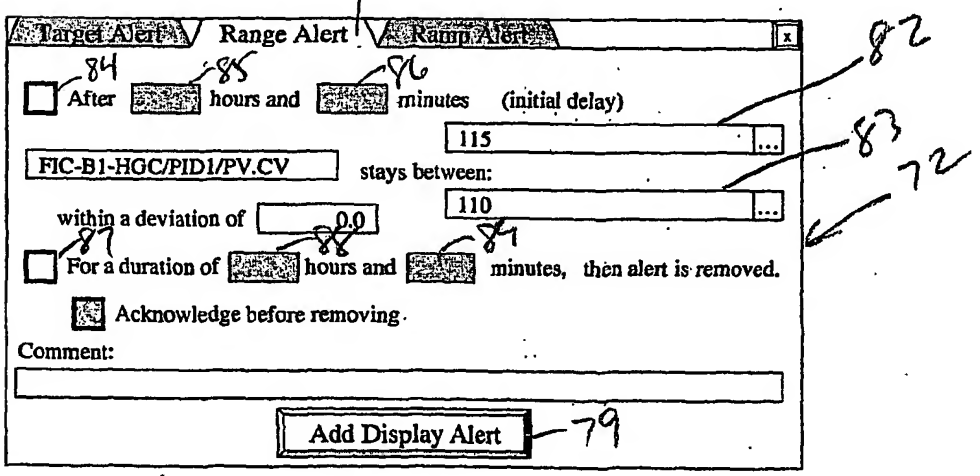

Target Alert
Range Alert
Ramp Alert
After hours and minutes (initial delay)
115
FIC-B1-HGC/PID1/PV.CV
stays between:
110
within a deviation of 0.0
For a duration of hours and minutes, then alert is removed.
Acknowledge before removing
Comment:
Add Display Alert

FIG 12

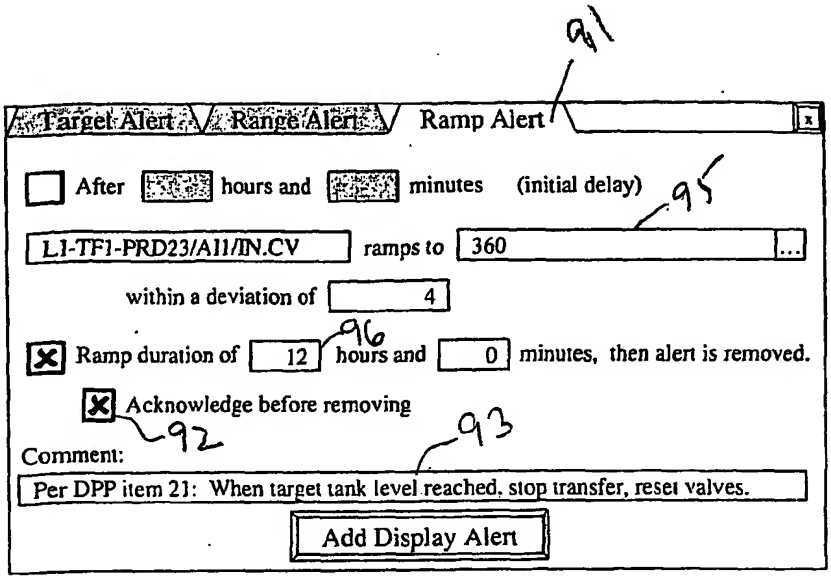

91
Target Alert
Range Alert
Ramp Alert
After
hours and
minutes
(initial delay)
95
L1-TF1-PRD23/AI1/IN.CV
ramps to
360
within a deviation of
4
96
Ramp duration of
12
hours and
0
minutes, then alert is removed.
Acknowledge before removing
92
93
Comment:
Per DPP item 21: When target tank level reached, stop transfer, reset valves.
Add Display Alert

Fig 13

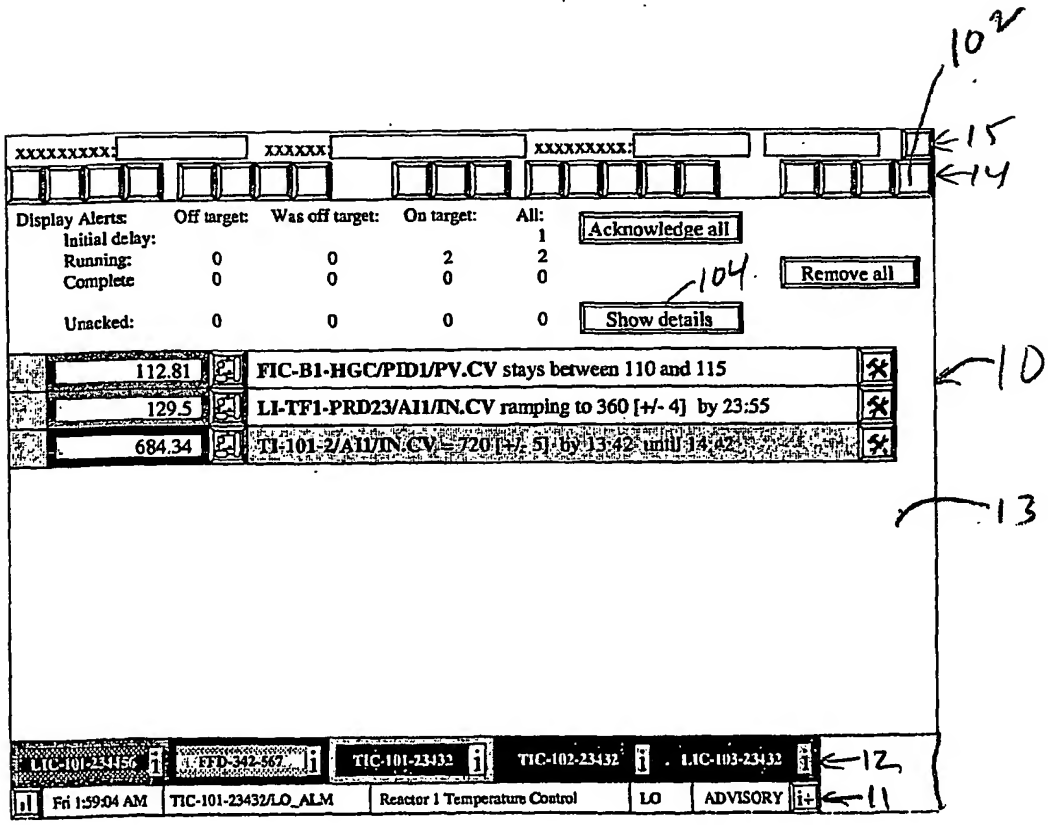

102
15
14
Display Alerts:
Off target:
Was off target:
On target:
All:
Initial delay:
1
Running:
0
0
2
2
Complete
0
0
0
0
Unacked:
0
0
0
0
Acknowledge all
Remove all
104
Show details
112.81
FIC-B1-HGC/PID1/PV.CV stays between 110 and 115
129.5
LI-TF1-PRD23/AI1/IN.CV ramping to 360 [+/- 4] by 23:55
684.34
TI-101-2/AI1/IN.CV=720 [+/- 5] by 13:42 until 14:42
10
13
TIC-101-23432
TIC-102-23432
LIC-103-23432
12
Fri 1:59:04 AM
TIC-101-23432/LO_ALM
Reactor 1 Temperature Control
LO
ADVISORY
11

Fig 14

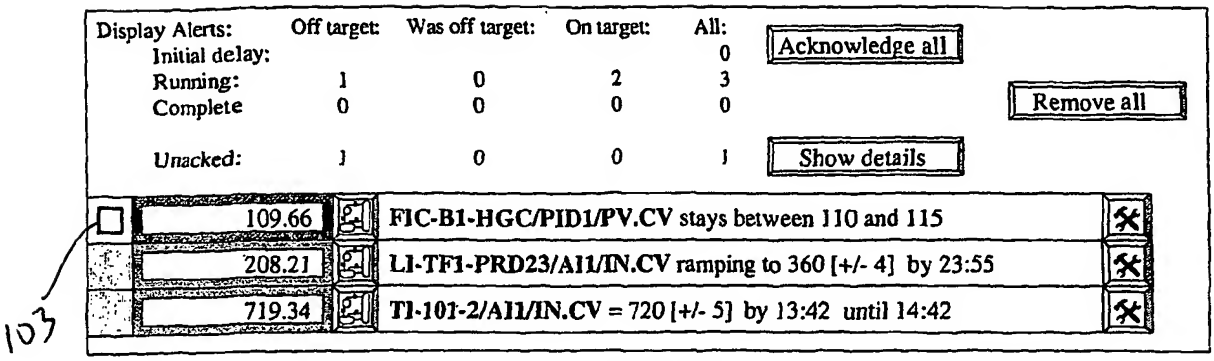



FIG 15

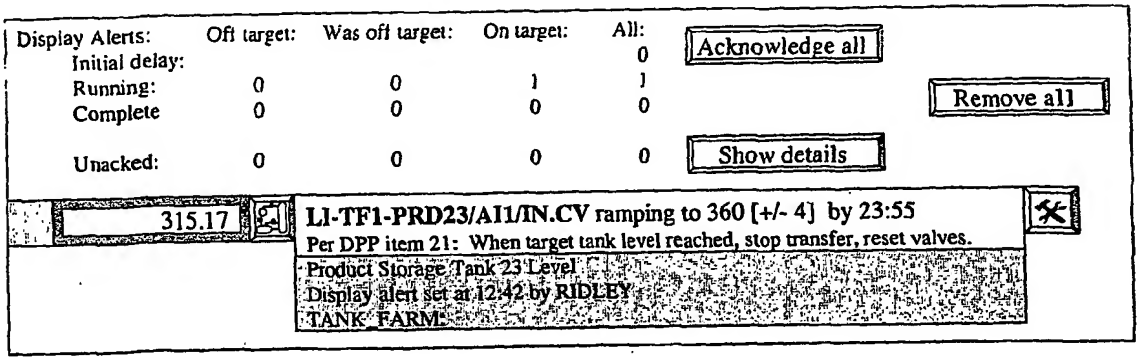



FIG. 16

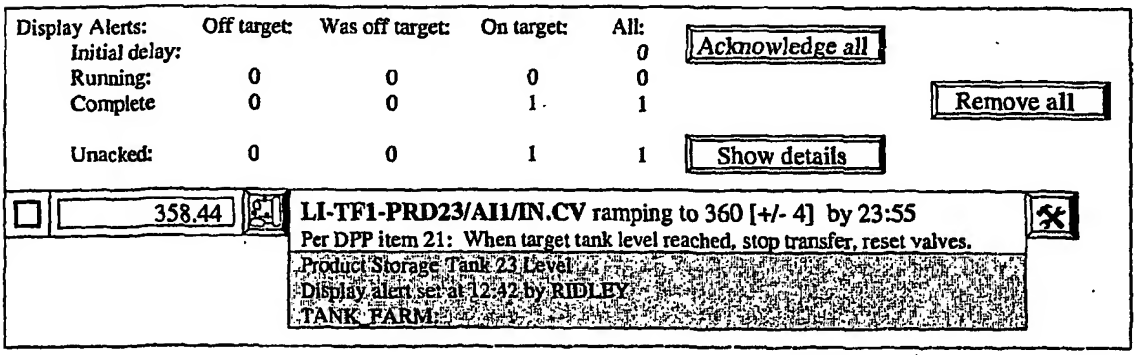



FIG. 17

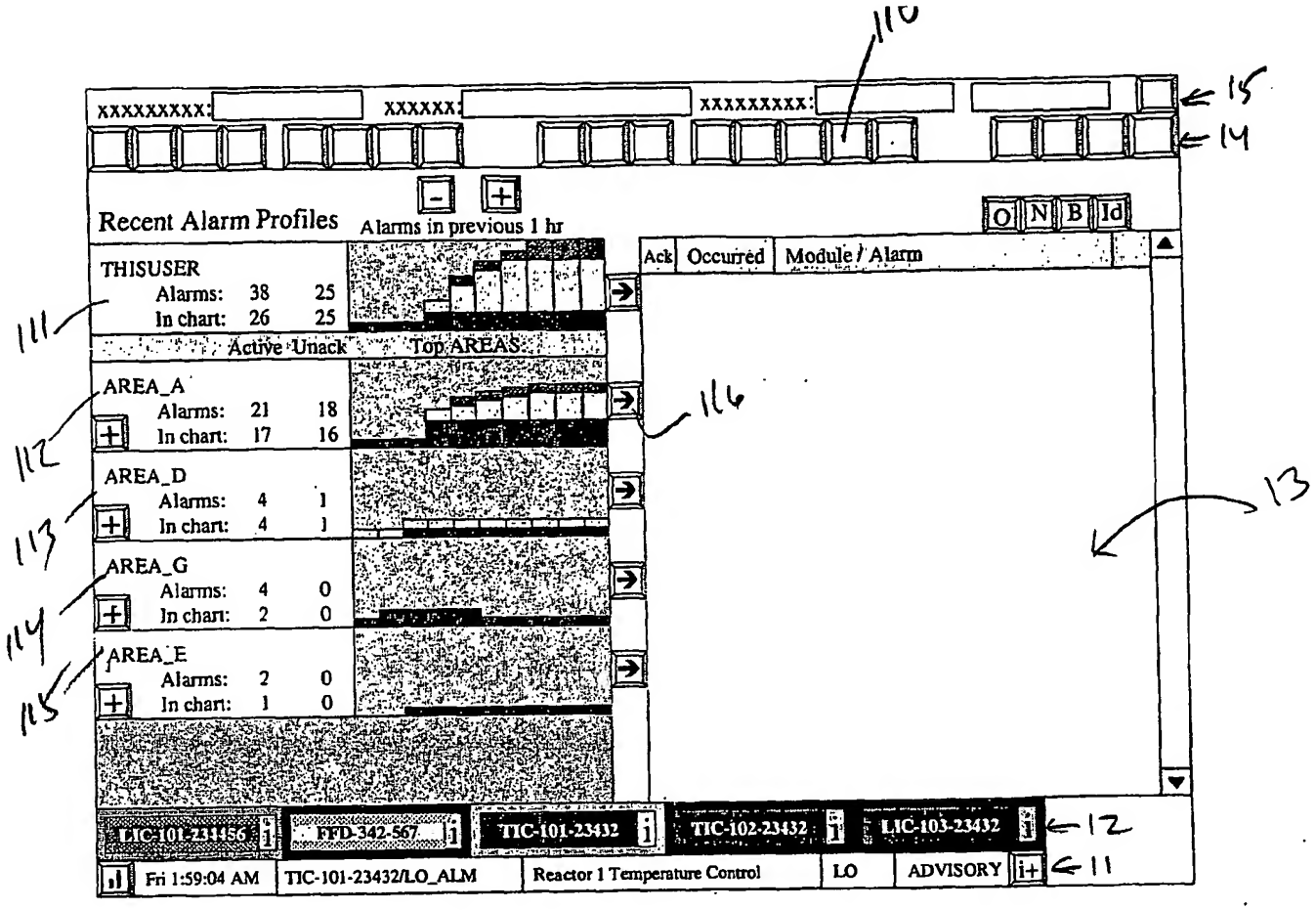

XXXXXXXXX:
XXXXXX:
XXXXXXXXX:
Recent Alarm Profiles
Alarms in previous 1 hr
O N B Id
Ack Occurred Module / Alarm
THISUSER
Alarms: 38 25
In chart: 26 25
Active Unack
Top AREAS
AREA_A
Alarms: 21 18
In chart: 17 16
AREA_D
Alarms: 4 1
In chart: 4 1
AREA_G
Alarms: 4 0
In chart: 2 0
AREA_E
Alarms: 2 0
In chart: 1 0
LIC-101-23456
FFD-342-567
TIC-101-23432
TIC-102-23432
LIC-103-23432
Fri 1:59:04 AM
TIC-101-23432/LO_ALM
Reactor 1 Temperature Control
LO
ADVISORY
110
15
14
111
112
113
114
115
116
13
12
11

FIG 18

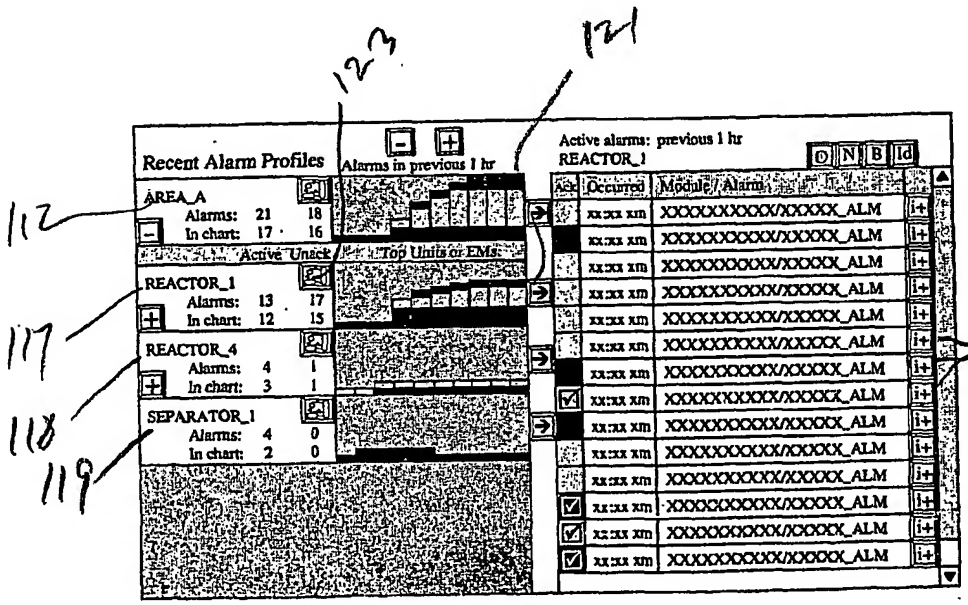

Recent Alarm Profiles
Alarms in previous 1 hr
Active alarms: previous 1 hr
REACTOR_1
O N B Id
Ack Occurred Module / Alarm
AREA_A
Alarms: 21 18
In chart: 17 16
Active Unack
Top Units or EMs
REACTOR_1
Alarms: 13 17
In chart: 12 15
REACTOR_4
Alarms: 4 1
In chart: 3 1
SEPARATOR_1
Alarms: 4 0
In chart: 2 0
123
121
112
117
118
119
122

FIG 19

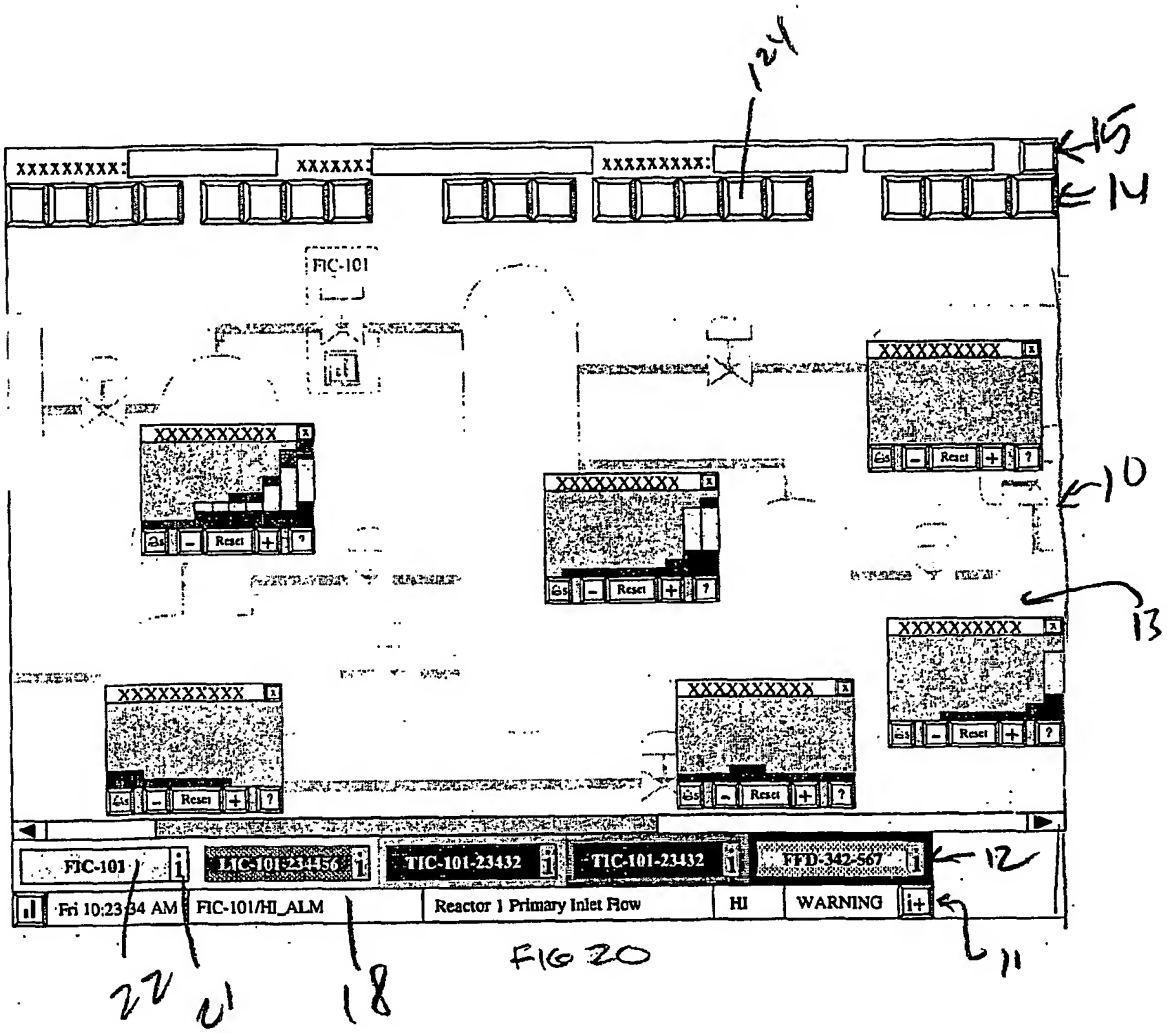

XXXXXXXXX:
XXXXXX:
XXXXXXXXX:
FIC-101
XXXXXXXXXX
Reset
FIC-101
LIC-101-23456
TIC-101-23432
TIC-101-23432
FFD-342-567
Fri 10:23:34 AM
FIC-101/HI_ALM
Reactor 1 Primary Inlet Flow
HI
WARNING
12
11
10
13
14
15
16
18
21
22

FIG 20

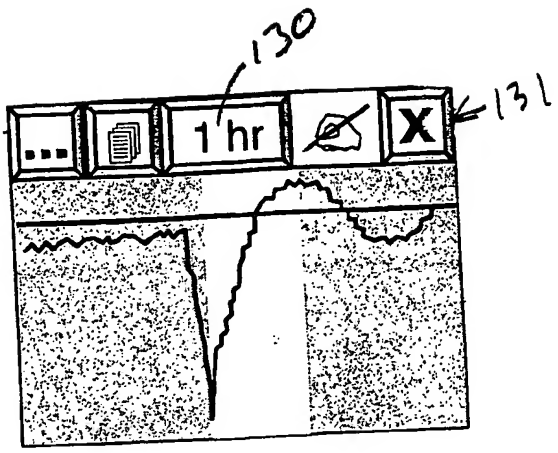



FIG 21

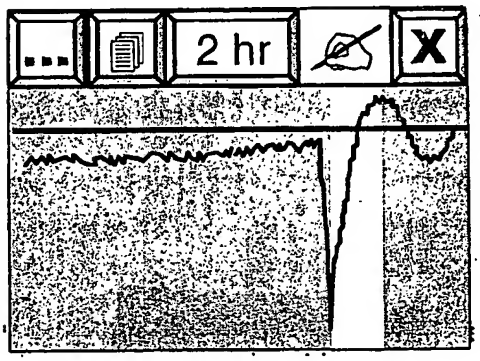



FIG 22

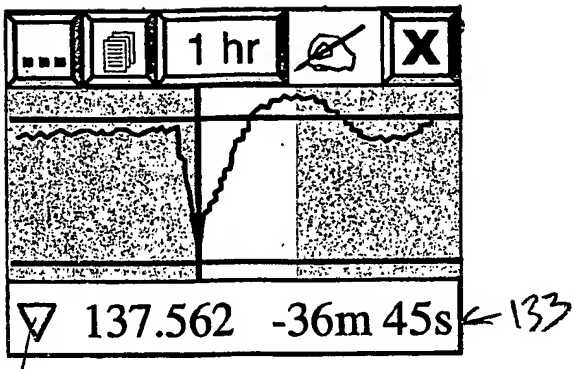



FIG 23

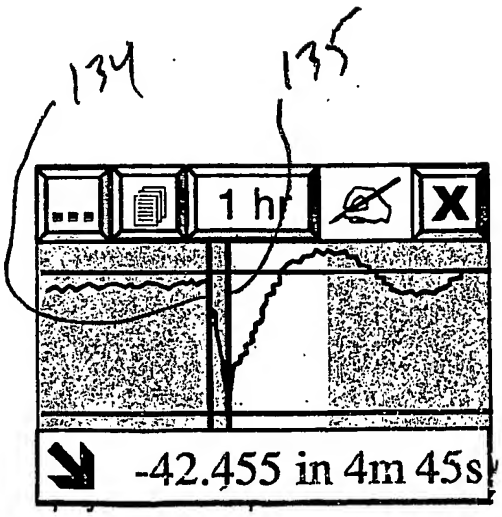
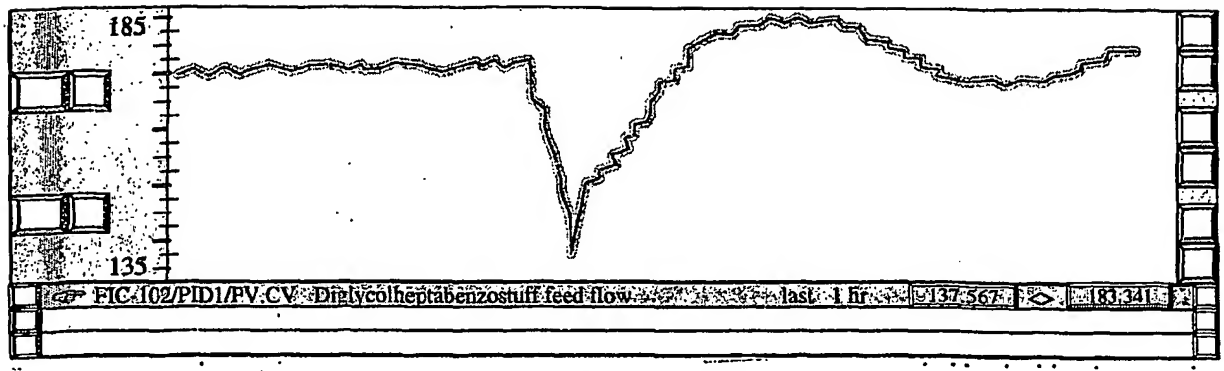
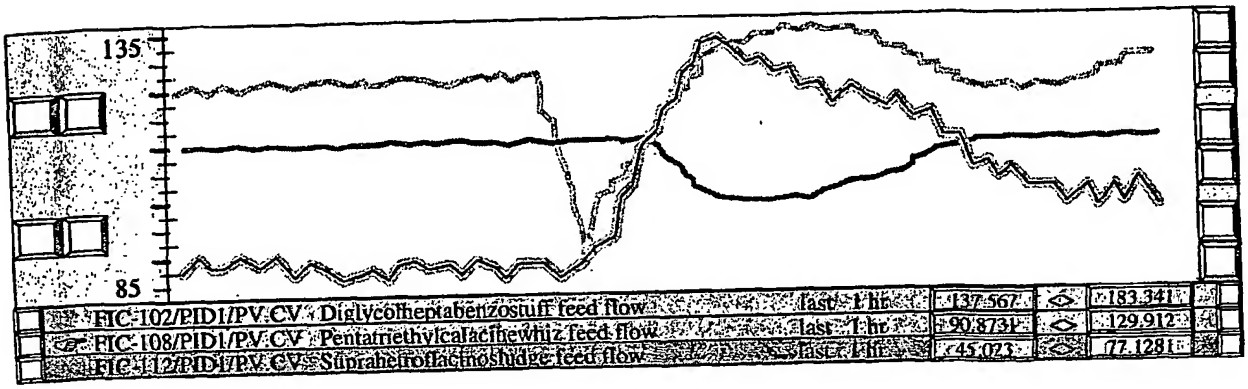


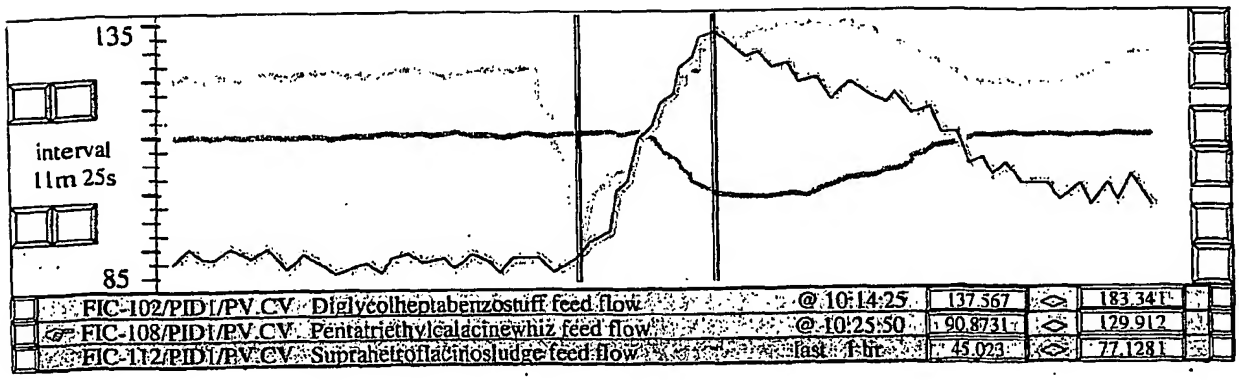

FIG 24




F1625




F1626




F1627

# INTERNATIONAL SEARCH REPORT

Inten ial Application No
PC_ _S2005/015537

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05B19/042

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>Y | GB 2 372 365 A (* FISHER-ROSEMOUNT SYSTEMS, INC) 21 August 2002 (2002-08-21)<br>the whole document | 1-5,11, 12,14<br>6-10,13, 15-20 |
| X | US 2002/022894 A1 (ERYUREK EVREN ET AL)<br>21 February 2002 (2002-02-21)<br>the whole document | 1 |
| Y | US 2004/075689 A1 (SCHLEISS DUNCAN ET AL)<br>22 April 2004 (2004-04-22)<br>the whole document | 6-10,13, 15-20 |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 19 August 2005 | 29/08/2005 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31–70) 340–2040, Tx. 31 651 epo nl,<br>Fax: (+31–70) 340–3016 | Morrish, I |

# INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT ;2005/015537

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| GB 2372365 A | 21-08-2002 | US 6774786 B1 | 10-08-2004 |
| | | DE 10154534 A1 | 27-06-2002 |
| | | JP 2002222012 A | 09-08-2002 |
| | | US 2002055790 A1 | 09-05-2002 |
| | | US 2005012608 A1 | 20-01-2005 |
| | | US 2002077711 A1 | 20-06-2002 |
| US 2002022894 A1 | 21-02-2002 | CN 1522391 A | 18-08-2004 |
| | | CN 1529836 A | 15-09-2004 |
| | | EP 1395884 A2 | 10-03-2004 |
| | | EP 1393138 A2 | 03-03-2004 |
| | | JP 2004530983 T | 07-10-2004 |
| | | JP 2004533056 T | 28-10-2004 |
| | | WO 02095509 A2 | 28-11-2002 |
| | | WO 02095510 A2 | 28-11-2002 |
| | | US 2002163427 A1 | 07-11-2002 |
| | | US 2005007249 A1 | 13-01-2005 |
| | | US 2002147511 A1 | 10-10-2002 |
| | | CN 1325038 A | 05-12-2001 |
| | | EP 1158019 A2 | 28-11-2001 |
| | | JP 2002173597 A | 21-06-2002 |
| | | TW 522435 B | 01-03-2003 |
| | | US 2002008470 A1 | 24-01-2002 |
| | | US 2005079447 A1 | 14-04-2005 |
| | | CN 1494668 A | 05-05-2004 |
| | | CN 1496500 A | 12-05-2004 |
| | | CN 1537258 A | 13-10-2004 |
| | | CN 1494669 A | 05-05-2004 |
| | | CN 1494670 A | 05-05-2004 |
| | | CN 1494671 A | 05-05-2004 |
| | | EP 1366397 A2 | 03-12-2003 |
| | | EP 1364262 A2 | 26-11-2003 |
| | | EP 1366398 A2 | 03-12-2003 |
| | | EP 1366399 A1 | 03-12-2003 |
| | | EP 1366400 A2 | 03-12-2003 |
| | | EP 1364263 A2 | 26-11-2003 |
| | | JP 2004537773 T | 16-12-2004 |
| | | JP 2004523841 T | 05-08-2004 |
| | | JP 2004526243 T | 26-08-2004 |
| | | JP 2004532449 T | 21-10-2004 |
| | | JP 2004529418 T | 24-09-2004 |
| | | JP 2004533036 T | 28-10-2004 |
| | | WO 02071168 A1 | 12-09-2002 |
| | | WO 02071169 A2 | 12-09-2002 |
| | | WO 02071170 A2 | 12-09-2002 |
| | | WO 02071171 A2 | 12-09-2002 |
| | | WO 02071172 A2 | 12-09-2002 |
| | | WO 02071173 A2 | 12-09-2002 |
| | | US 2002123856 A1 | 05-09-2002 |
| | | US 2002161940 A1 | 31-10-2002 |
| | | US 2002147506 A1 | 10-10-2002 |
| | | US 2002169514 A1 | 14-11-2002 |
| | | US 2003028268 A1 | 06-02-2003 |
| | | US 2004204775 A1 | 14-10-2004 |
| | | US 2002123864 A1 | 05-09-2002 |
| | | US 2005033466 A1 | 10-02-2005 |
| US 2004075689 A1 | 22-04-2004 | CN 1542575 A | 03-11-2004 |

# INTERNATIONAL SEARCH REPORT

Inten ial Application No
PC... S2005/015537

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 2004075689 A1 | | DE 10348563 A1 | 27-05-2004 |
| | | DE 10348564 A1 | 13-05-2004 |
| | | GB 2395801 A | 02-06-2004 |
| | | GB 2396026 A | 09-06-2004 |
| | | JP 2004199655 A | 15-07-2004 |
| | | JP 2004199656 A | 15-07-2004 |
| | | US 2005096872 A1 | 05-05-2005 |
| | | US 2004153804 A1 | 05-08-2004 |